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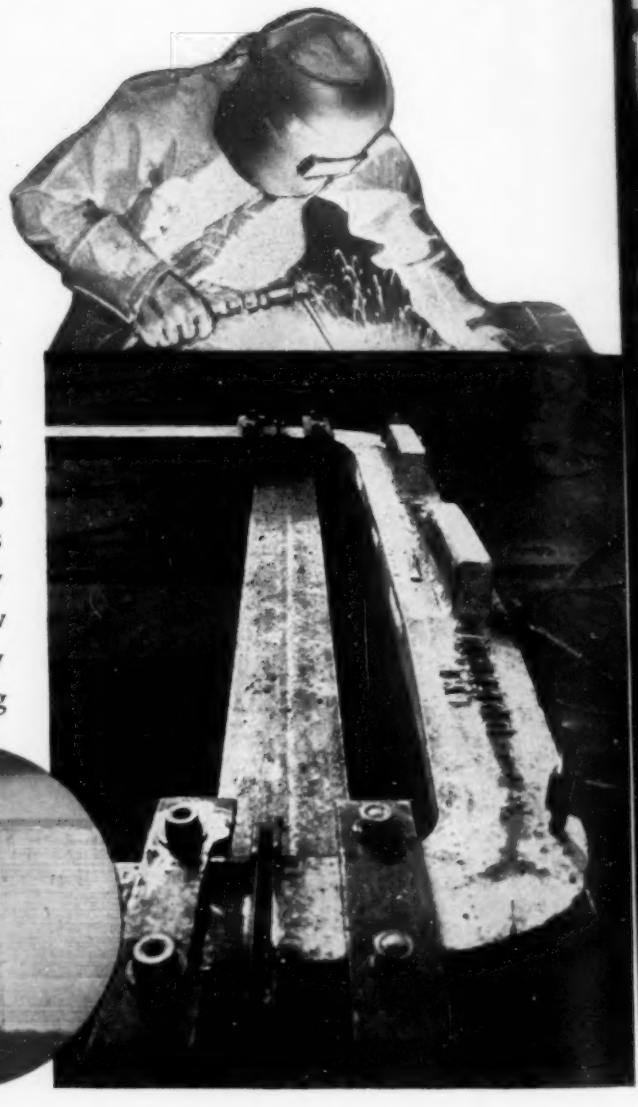

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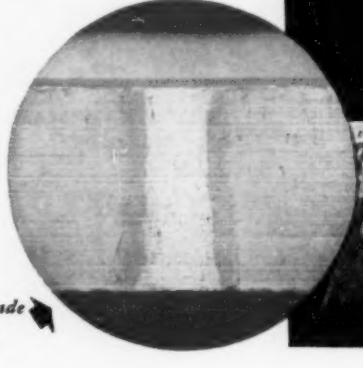

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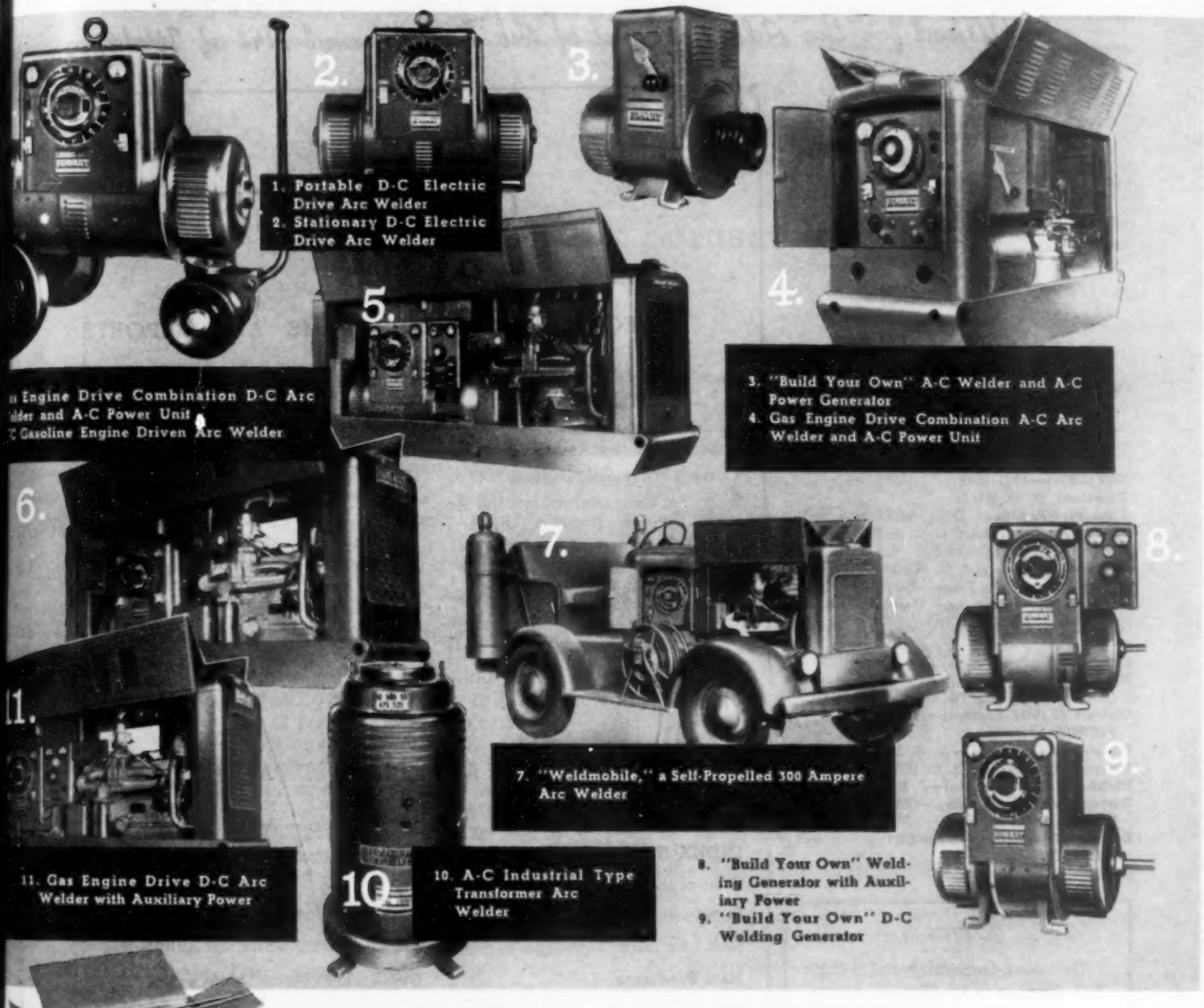

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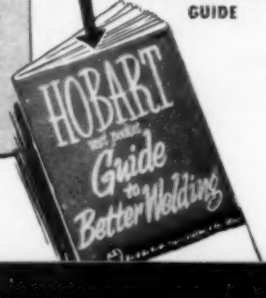

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AUGUST 1948

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The Journal of The American Welding Society

VOLUME 27 • NUMBER 8 • AUGUST 1948

Here's a Way to Preheat Castings

Build a Temporary Firebrick Furnace to Do the Job

By F. C. Geibig*

BEFORE fusion welding an iron casting you should preheat it. This is done because iron castings are subject to expansion and contraction stresses when they are heated or cooled unevenly. These stresses may cause distortion or even break the part. An easy way to preheat a casting is to build a temporary firebrick furnace to meet the needs of the job. Charcoal is usually used for fuel because it burns slowly and evenly and is economical.

When a casting like this broken automobile gear case comes into the shop, you will probably decide to preheat it to a uniform temperature of 800 or 1000° F. The bricks for the floor of the furnace should be laid directly on the concrete floor of the welding shop and a few shovelfuls of dry sand spread over the bricks to fill the cracks. Place the casting in position as shown in Fig. 1 and leave enough space between the brick wall and the casting to allow for the charcoal.

Next, build the walls, leaving a 2-in. space between the bricks on the first course. When bricks are placed on end near each opening in the first course, as shown in Fig. 2, they act as dampers. Build the walls a few inches higher than the top of the gear case. Finally, place two bricks on edge on the top of the wall, as shown in Fig. 2, and lay a steel rod or light angle iron across them. This rod serves as a support for the asbestos paper roof. It also forms a flue that produces sufficient draft for the heating operation.

Be sure the casting is in the welding position and is supported on bricks. You are now ready to cover the

* The Linde Air Products Co., Newark, N. J.

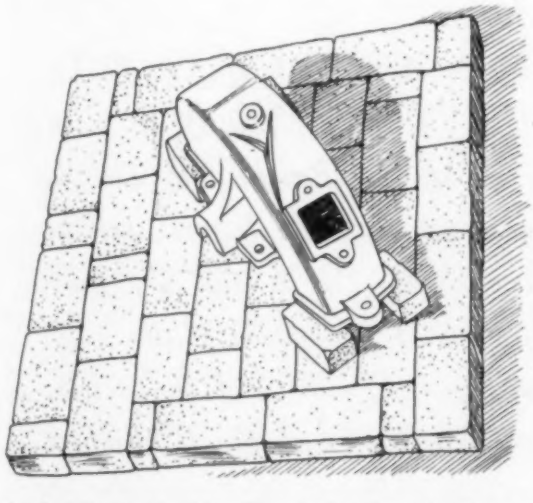

Fig. 1—Lay the Bricks Close Together to Form the Floor of the Preheating Furnace. You Can Estimate the Dimensions by Placing the Casting in Welding Position

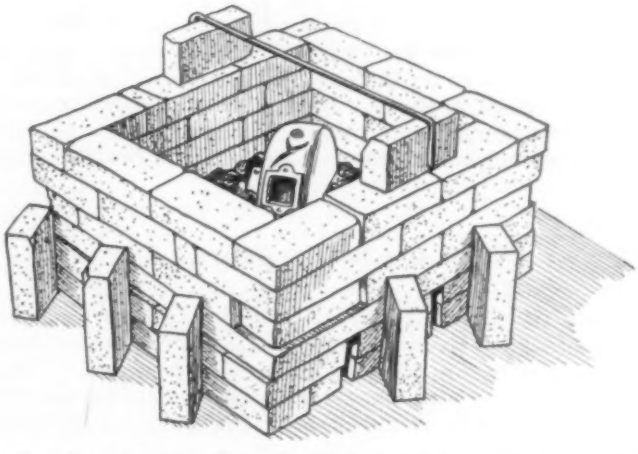

Fig. 2—Bricks Should Be Placed Next to the Openings Left in the Lower Course to Act as Dampers. The Bricks and Rod on the Top Support the Roof

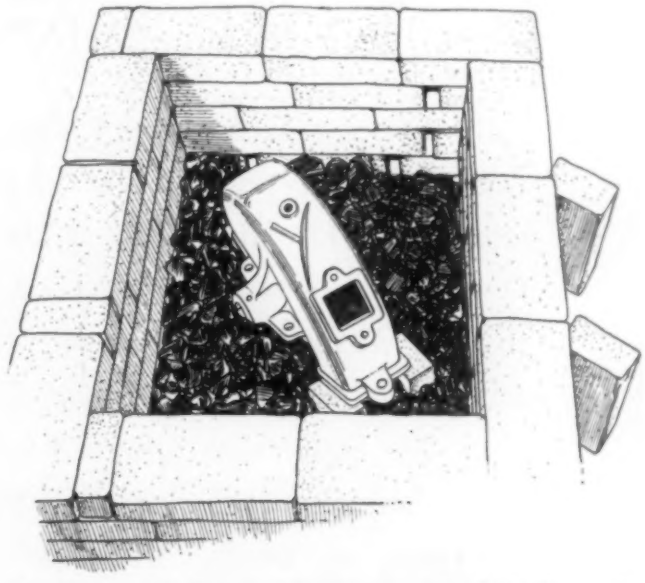

Fig. 3—Cover the Bottom of the Furnace with a Light Charcoal Layer. More Charcoal Can Be Added When It Is Needed

Fig. 4—After the Glowing Fire Is Covered with Asbestos, a Blast from an Air Hose Through the Draft Holes Completely Ignites All the Charcoal

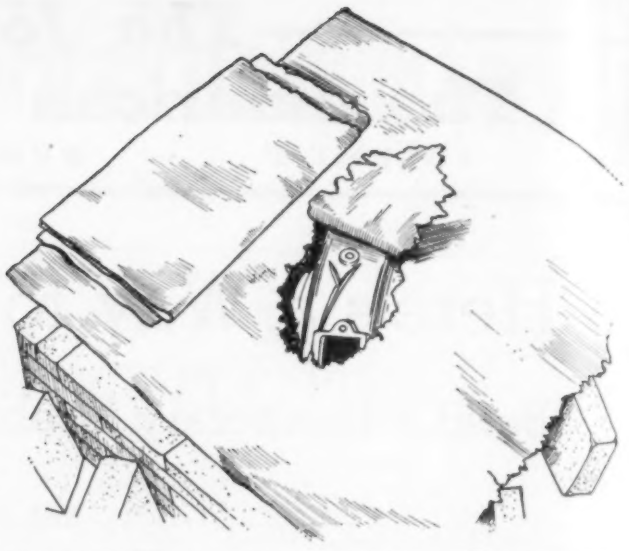

Fig. 5—To Expose the Part for Welding, Make a Flap-Like Break in the Asbestos Paper. Folded Asbestos Paper Will Protect You from the Heat During Welding

bottom of the furnace with a light layer of charcoal as shown in Fig. 3. You can add more charcoal when it is needed. You can start the fire by playing the flame of the blowpipe over the charcoal until it begins to glow evenly. Then cover the furnace with a sheet of asbestos paper as shown in Fig. 4. To make sure that the charcoal is really burning, some welding operators blow a blast from the compressed air hose through the bottom draft holes.

Testing the Temperature

Once the fire is started, it is only necessary to check occasionally to make sure the part is being heated uniformly and to add more charcoal if it is needed. After half an hour, check the temperature of the casting by making a flap-like break, as shown in Fig. 5. Most shops use temperature-indicating crayons because this is the most accurate method for testing temperatures.

When a temperature of about 1000° F. is reached, remove the two bricks on top of the wall to lower the asbestos paper for welding. You can place a piece of asbestos paper, loosely folded three or four times, on top of the furnace, as shown in Fig. 5 for protection from the heat.

As soon as the welding is completed, close the asbestos flap, place the folded asbestos paper over it and put the damper bricks in front of the draft holes. Then let the fire burn itself out. The casting will cool slowly and evenly and should not be removed until it is completely cold. When more than one charcoal fire is burning, the shop building should be well ventilated.

LECTURE SERIES
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The first Educational Lecture Series at the Annual Meeting in Philadelphia will give members and guests of A. W. S. an opportunity to learn more about "The Metallurgy of Arc Welds in Steel". Presented by Dr. R. D. Stout, Department of Metallurgy, Lehigh University, the lectures will be given on Monday, Tuesday and Wednesday, October 25, 26 and 27, from 4:30 to 6:00 p. m. at the Commercial Museum and Convention Halls.

The lecture series, sponsored by the Educational Committee of the Society, will be an open meeting, a new feature of the Meeting to which all members and guests are cordially welcomed.

Future Developments in Welded Steel Buildings*

By Arsham Amirikian†

The problems of design with particular reference to welded steel structures are discussed by the author. The elements of a new "Articulated Wedge Beam Framing" are described and the advantages clearly indicated.

THE hectic construction activities of the postwar era have not furnished as yet an opportunity for sober thinking and judicious planning. The tremendous backlog of normal construction accumulated during the war and the emergency years has created an abnormal condition in which peacetime standards and practice are difficult to attain. In the case of steel construction, the situation is further confused because of the acute shortage of steel—the leading major item on the list of critical materials—and the associated complications of allocations and procurement. Under these circumstances it is somewhat risky to make predictions regarding the trend of steel construction in the immediate future. However, assuming, or rather hoping, that the present wide gap between supply and demand will soon be narrowed and bridged, and a normal competitive market will eventually be restored, a long-range forecast on the type and extent of welded construction can be made.

Increased Use of Welding

To begin with, it is safe to state that there will be an increase in the number of welded steel structures in the future construction program. The considerations suggesting this increase are the proved economies in the cost of welded framing—as compared with the riveted type—and the savings in the steel tonnage resulting from the choice and use of the welded design. The importance of the latter factor cannot be overemphasized. The supply of steel will remain in the limited category probably for a long time. Of necessity, we must utilize welding in order to obtain optimum use of the available amount of steel.

Secondly, it is equally safe to predict that there will be certain improvements which will further the use of welding.

Speaking of improvements, the first thought that enters one's mind concerns the technique of welding and its cost. It is readily admitted that welding is an expensive process. Unfortunately, the designing engineer is often over-conscious of this fact. As a result, many steel structures are often over-designed simply because the designer has tried to keep the amount of the necessary welding to a minimum—with the consequent sacrifice in the amount of steel. Now it so happens that steel is not a cheap material; it, too, is expensive, and it will be more so in the future. On the other hand, as in the case of any manufacturing process, with increased use and demand, the unit cost of welding is bound to come down, so that in the future we may have a framing which will utilize more weld per ton of steel, yet have a lower cost because of its reduced weight.

New Problems in Design

In addition to the welding technique, there are two other sources of improvement which may affect the design of future steel structures. One of these concerns the methods of analysis and procedures of design. The needed study may or may not result in economies of framing. It will, however, give us a more realistic approach to the problem and a more dependable basis for design. The problem is this: A welded joint, even in its simplest form, may have initial stresses approaching the yield value of the base metal. When the connection is

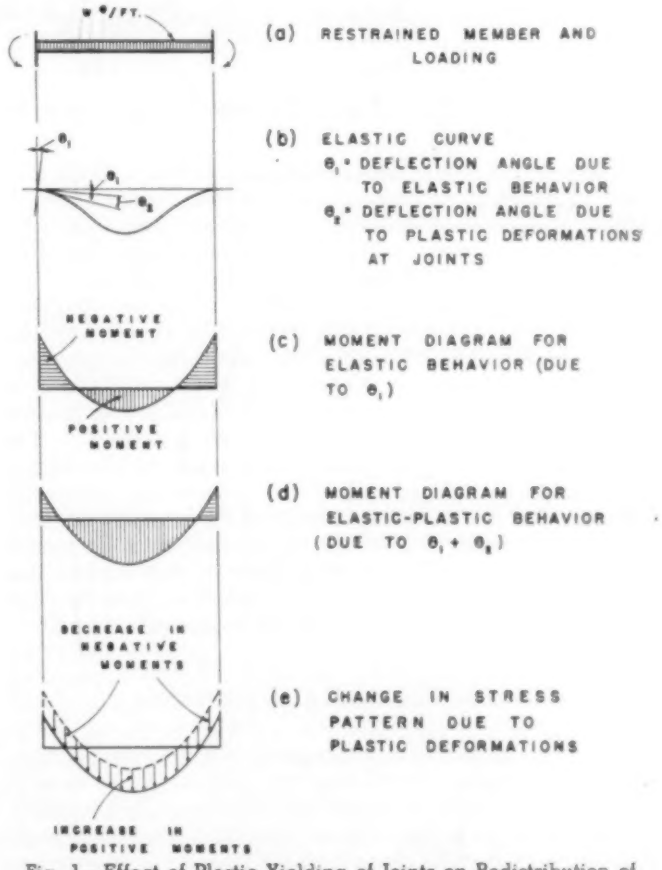

w #/FT.
(a) RESTRAINED MEMBER AND LOADING
(b) ELASTIC CURVE
θ1 = DEFLECTION ANGLE DUE TO ELASTIC BEHAVIOR
θ2 = DEFLECTION ANGLE DUE TO PLASTIC DEFORMATIONS AT JOINTS
NEGATIVE MOMENT
POSITIVE MOMENT
(c) MOMENT DIAGRAM FOR ELASTIC BEHAVIOR (DUE TO θ1)
(d) MOMENT DIAGRAM FOR ELASTIC-PLASTIC BEHAVIOR (DUE TO θ1 + θ2)
DECREASE IN NEGATIVE MOMENTS
INCREASE IN POSITIVE MOMENTS
(e) CHANGE IN STRESS PATTERN DUE TO PLASTIC DEFORMATIONS

Fig. 1—Effect of Plastic Yielding of Joints on Redistribution of Stress in a Restrained Member

* Presented at the Joint Meeting of the New York Chapter of the AMERICAN WELDING SOCIETY and the Metropolitan Section of the American Society of Civil Engineers, New York City, March 17, 1948.

† Head Designing Engineer, Bureau of Yards & Docks, Navy Dept., Washington, D. C.

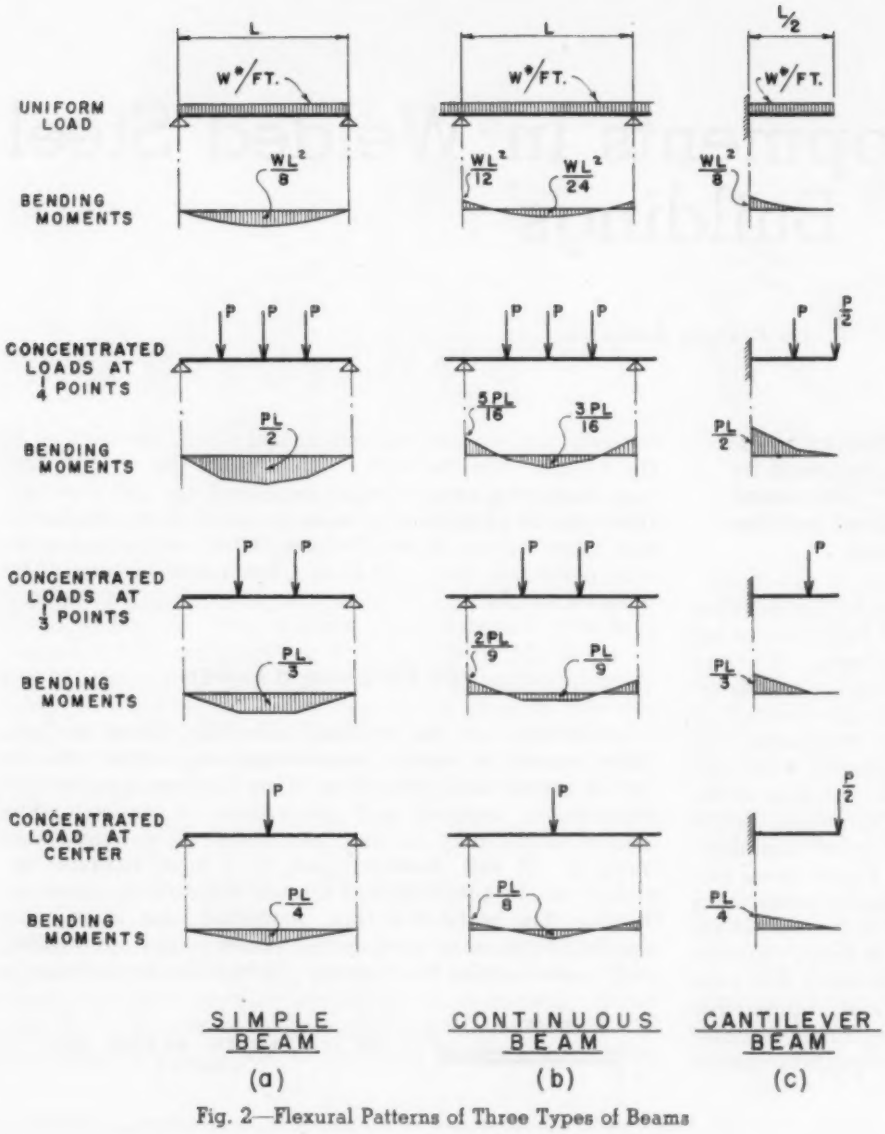


Fig. 2—Flexural Patterns of Three Types of Beams

subjected to loading, the combined stresses will then result in yielding. This plastic yielding constitutes, in effect, a slip or discontinuity in the elastic behavior of the joint which, in turn, will cause a redistribution of stress in the connected member. A simplified concept of the effect of such plastic deformations is shown diagrammatically in Fig. 1. Under dead loading, as well as under initially applied loading, the changes of stress in members of a framing due to plastic yielding at the joints may be of such magnitude as to require a revision of our present methods of analysis of continuous structures. The Bureau of Yards and Docks has recognized the importance of this problem and is now sponsoring, under the guidance of the Welding Research Council, a research project at Lehigh University. It is hoped that the results of this program will shed some light on the subject and furnish the experimental data necessary for the development of a modified procedure of analysis and design.

Newer Arrangements of Framing

The other source of improvement concerns the arrangements of framing. It is true that worth-while savings have already been accomplished by the use of welding. There are a great number of examples, including some outstanding contributions by the Bureau of Yards and Docks, which could be cited in support of this contention. But, it is equally true that these savings, impressive as they are, do not represent the ultimate reductions that can be realized in weight as well as in cost. In spite of all refinements in analysis, the present practice of welded structural design still involves a great deal of waste in the form of material not fully utilized or stressed in all parts of a devised framing. This is due to the fact that the stresses in the various members of a continuous framing follow a rather irregular pattern. In providing elements of framing for such a pattern, the choice of sections is dictated by the maximum stress, which may occur at only one point or at a limited zone of the member. The question is then what can be done to eliminate or minimize such waste in future structures.

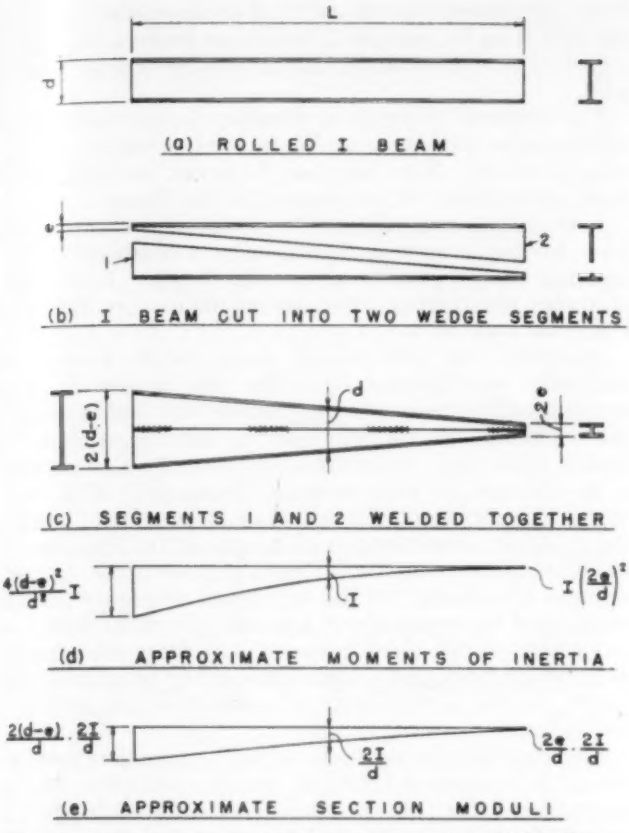
The creation of an ideal framing so proportioned that all parts and component elements are equally stressed has long been an intriguing problem for the designing engineer. Unfortunately, conventional concepts of framing and practice have not been conducive to the attainment of the desired goal. Limitations imposed by available steel sections for framing, and the fear on the part of many to shape the needed sections by welding, have been further obstacles. To be frank, we cannot hope for much improvement in our future welded designs, unless we are ready and willing to abandon, at least partially, our present concepts and try to devise newer arrangements of framing.

Wedge-Beam Framing

As a contribution to efforts dedicated to this objective, the writer recently presented a new framing arrangement called "Articulated Wedge-Beam Framing." This new system is predicated on two important considerations normally affecting the choice of a framing; namely, economy of cost and savings in weight. Since the new arrangement is little known, a somewhat elaborate description of the basic principles involved, the range of application and the advantages to be derived from its use is believed to be of interest.

Basic Principle.—The concept of "Wedge-Beam" framing is predicated on the principle of a simple cantilever beam. Unlike any other member in flexure, whether it be in a simple or continuous framing, a loaded cantilever has a consistent or regular pattern of bending. As will be noted from the typical bending moment contours shown in Fig. 2, it is the characteristic of this pattern that the moment ordinates under any system of lateral loading increase from a minimum at the free end to a maximum at the support. For a uniform loading, the variation between the two limiting values is parabolic, while that due to a concentrated loading is linear.

In conventional design, with the use of rolled sections of constant cross section, this particular flexural pattern is of little significance. Since the selection of a section for flexure is governed by the maximum moment, the important thing under this consideration is the relative value of the maximum moment rather than the bending pattern.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d
(a) ROLLED I BEAM
(b) I BEAM CUT INTO TWO WEDGE SEGMENTS
(c) SEGMENTS 1 AND 2 WELDED TOGETHER
(d) APPROXIMATE MOMENTS OF INERTIA
(e) APPROXIMATE SECTION MODULI

Fig. 3—Construction and Properties of the Wedge-Beam

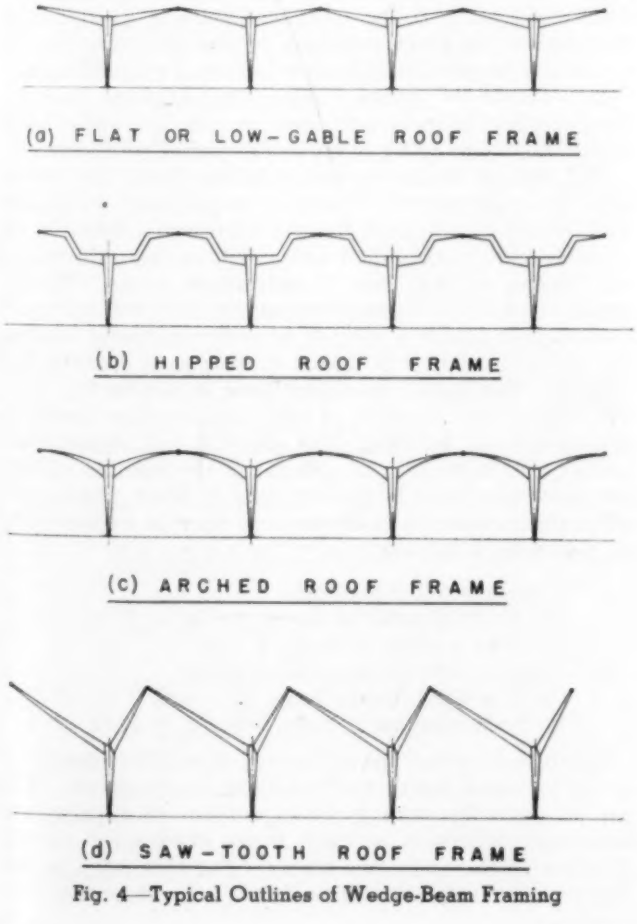

Fig. 4—Typical Outlines of Wedge-Beam Framing

From this point of view, if a hinge be introduced at the center of a single-span beam, thus resulting in two cantilevers, by reference to Fig. 2, a comparison of the attained maximum moment values under a given system of symmetrical loading may be made as follows:

Type of Beam:	Continuous Beam	Simple Beam	Cantilever (Span = L/2)
Location of Maximum Moment:	Support	Center	Support
(*a*) Uniform load, wt./ft.			
Maximum moment	1/12 wL^2	1/8 wL^2	1/8 wL^2
Relative magnitude	1	3/2	3/2
(*b*) Loads P at center and L/4 pts.			
Maximum moment	5/16 PL	1/2 PL	1/2 PL
Relative magnitude	1	8/5	8/5
(*c*) Loads P at L/3 pts.			
Maximum moment	2/9 PL	1/3 PL	1/3 PL
Relative magnitude	1	3/2	3/2
(*d*) Loads P at center			
Maximum moment	1/8 PL	1/4 PL	1/4 PL
Relative magnitude	1	2	2

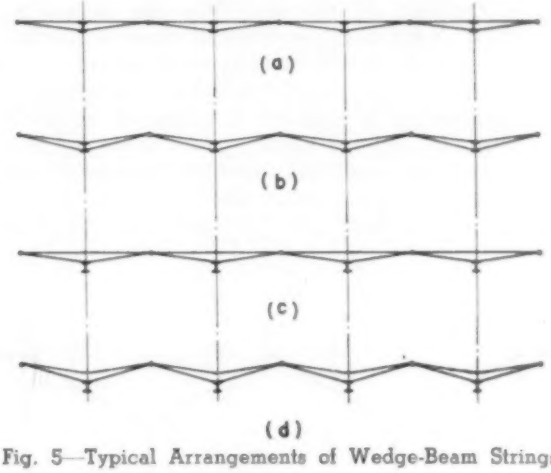

Fig. 5—Typical Arrangements of Wedge-Beam Strings

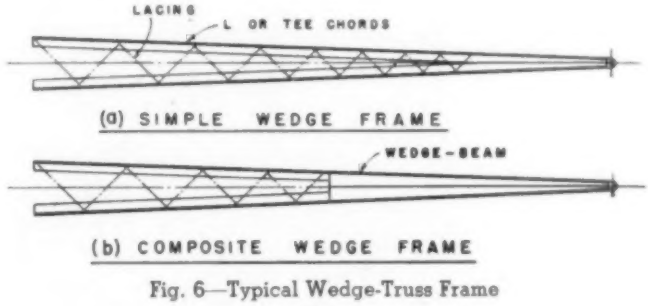

Fig. 6—Typical Wedge-Truss Frame

According to the tabulated data, a beam of constant cross section will carry about the same load whether it is used as a simply supported beam or as a cantilever beam spanning one-half the distance of the simple beam. For a fully continuous beam of comparable span, the load carrying capacity of the same section is greater by a percentage varying from 50 to 100% in accordance with the loading.

On the other hand, if the beam of constant cross section is cut and welded together in the manner shown in Fig. 3 (*a*), (*b*) and (*c*), the resulting wedge-shaped element, with its correspondingly increased moment of inertia at the deeper end, could then be used to greater advantage as a cantilever beam. This will be evident from the moments of inertia and section moduli diagrams

of the wedge beam as sketched in Fig. 3 (*d*) and (*e*). It is to be noted that the variation of the section modulus, which also represents the resisting moment of the beam, is approximately linear, and conforms closely to the bending moment curves of the cantilever. If the origin of the cut of the beam web is close to the flange, the section modulus of the composed wedge at the deep end will become about twice as large as the section modulus of the original beam. Accordingly, the load carrying capacity of the beam as a cantilever will be increased approximately 100%. Under a uniform loading, the corresponding gains in efficiency over a simply supported beam of constant cross section will then be 100% and that over a continuous beam about 33%.

This gain in load carrying capacity of the wedge-shaped beam section and the conformance of its section moduli to the bending moment curve of a cantilever constitute the basic principles of "Articulated Wedge-Beam" framing.

Range of Application.—The principle of wedge-beam design can easily be utilized in most types of building framings. It is particularly adaptable to single-story buildings and roof framings. For this purpose, all that is necessary is to introduce a hinge at the middle of each beam or girder span and thus transform the system into a series of tapering cantilevers. For the necessary stability, these cantilevers are fixed at their supports; and the hinged connections at the free ends provide for transfer of thrust, and shear under unbalanced loading.

The supporting system for a string of wedge-beams may consist of a series of girders or columns. When used in a roof framing, they may assume various elevational outlines in accordance with the desired roof contour. Some of these outlines are sketched in Figs. 4 and 5.

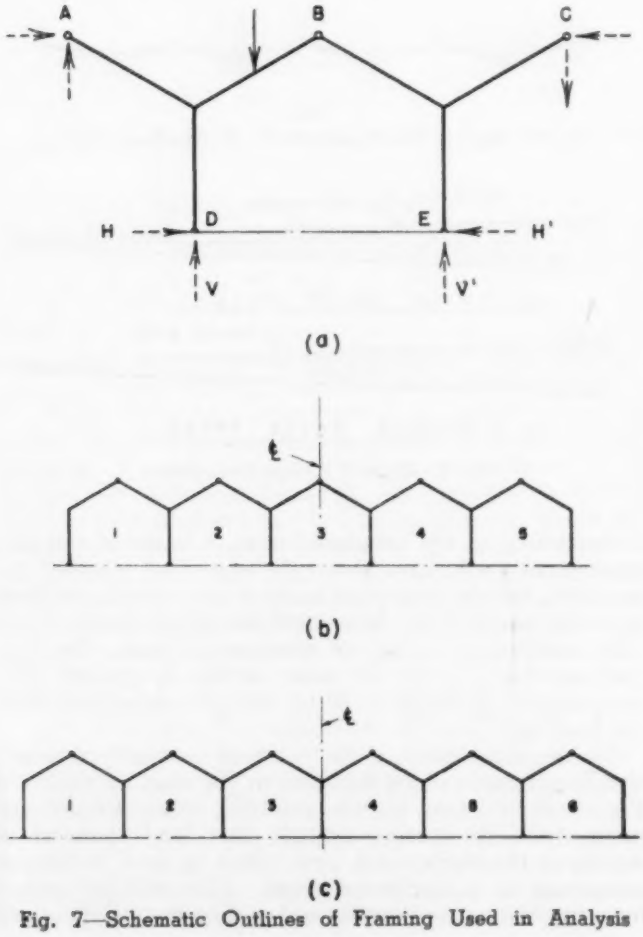

Fig. 7—Schematic Outlines of Framing Used in Analysis

While, in general, a symmetrical arrangement for hinge location is to be preferred, in certain frames, such as in Fig. 4 (*d*), an unsymmetrical arrangement may also be used.

The columns or vertical members in any articulated wedge-beam framing may be tapered or have constant cross sections. In either case, however, no restraint or rigid connections will be required at the bases.

A wedge member can also be obtained in the form of a truss having a tapering depth, or by a combination of a tapering truss segment and a wedge-beam. Two typical examples illustrating these arrangements are shown in Fig. 6 (*a*) and (*b*).

Analysis.—An articulated wedge-beam framing is statically semideterminate. By this statement it is meant that the stresses in the framing are neither entirely indeterminate, as in the case of fully continuous or rigidly connected structures, nor entirely determinate, as in the case of pin-connected framings. This intermediate condition of determinency is, of course, brought about by the introduction of hinges in the framing, by which means the number of rigid joints capable to carry moment is reduced to the minimum necessary for the stability of the assembly as a whole. In other words, an articulated wedge-beam framing is a composite arrangement which possesses a sufficient rigidity to make it self-stable, as well as flexibility to conform or adapt it to a predetermined stress pattern.

The analytic characteristic of the arrangement is manifest by an interesting relation. It is evidenced in the fact that when a bay or span of an articulated framing is severed from the adjacent bays or spans, the resulting assembly becomes statically determinate. To illustrate this point, consider the assembly shown in Fig. 7 (*a*), which represents a part of a framing. It is to be noted that, except for the forces at the cut hinges *A* and *C*, the system is determinate in the form of a three-hinged bent; that is to say, the reactions at the bases of the bent or at the interior hinge *B* due to its own loading, as well as for the forces at the exterior hinges, can be determined by the use of the moment and force relations of statical equilibrium. Therefore, in the analysis of a framing having a given number of bays, one need consider the upper hinge reactions only in every other bay as unknown forces.

The partial determinency resulting from the articulated arrangement is of special importance in design, since the work required for the solution of stress in the frame is greatly simplified as a result of the reduction in the number of unknown or redundant forces. For example, the five-bay bent shown in Fig. 7 (*b*) will have only 4 unknowns under a system of unsymmetrical loading, and only 2 unknowns under symmetrical loading and framing. Similarly, the 6-bay bent shown in Fig. 7 (*c*) will require the solution of only 5 unknowns under an unsymmetrical loading, and only 3 for symmetrical loading and framing. In general, if the number of bays contained in a frame be indicated by n, then, mathematically, the number of unknowns, x, may be expressed by the following relations:

1. Unsymmetrical loading:
   (*a*) Even number of bays, $x = n - 1$.
   (*b*) Odd number of bays, $x = n - 1$.
2. Symmetrical loading and framing:
   (*a*) Even number of bays, $x = n/2$.
   (*b*) Odd number of bays, $x = (n - 1)/2$.

For the solution of the unknowns, it will be necessary to set up an equal number of relations or equations. This can be done by writing an expression of vertical and horizontal deflection at each hinge chosen for the application of the unknown forces. For this purpose, the "least work" method will be found advantageous. For

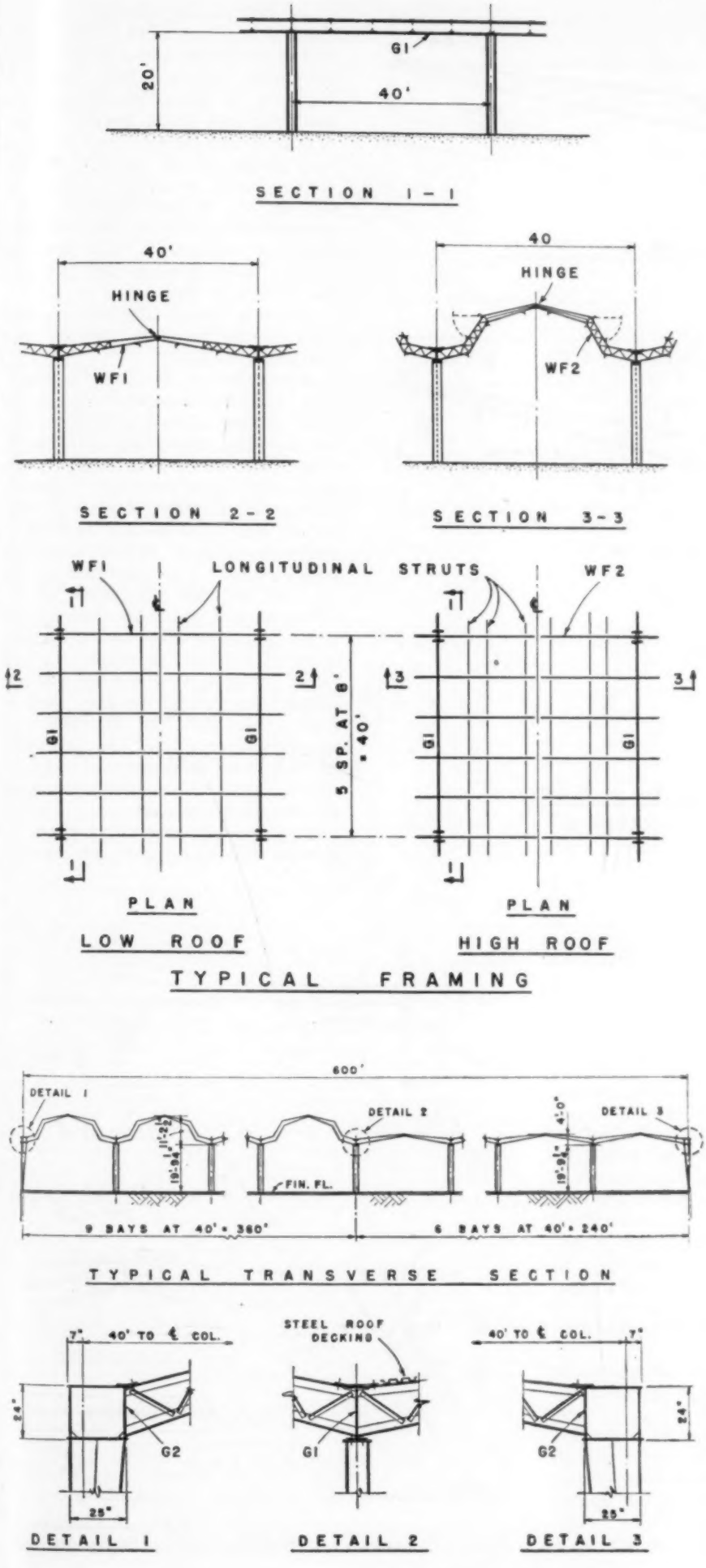

Fig. 8—Wedge-Beam Framing Arrangement for a Single-Story Building

Fig. 9—Wedge-Bean Bent Framing Arrangement and Details

further ease, the computations may be made semigraphically.

For an approximate solution, each bay framing may be treated independently as a three-hinged bent, neglecting the effect of adjacent member. In the case of symmetrical loading, the results obtained under this assumption will not differ materially from those of the exact analysis.

First Application of Wedge-Beam Framing

For a further illustration of the use of the system, as well as for bringing out the advantages derived by its adoption, an actual example of application will be given. This first utilization of the wedge-beam framing system was made in connection with the design of a proposed addition to an existing building. The actual construction of the project—a Naval production facility near Chicago—was, however, deferred.

The building in reference is a typical one-story industrial shop, commonly used to shelter a large production assembly and a storage area. The added floor space measures approximately 560 x 600 ft. In layout, the area is subdivided into 40- x 40 ft. bays by the columns, and the surmounting roof framing provides a minimum vertical clearance of 18 ft. under the main girders. One part of the building is provided with a high monitor roof and the other has a low roof with a small pitch.

Framing Arrangement.—The framing layout of the two typical bays is shown in Fig. 8, and a typical transverse section of the building is sketched in Fig. 9. As will be noted, the arrangement in either case consists of a series of wedge frames and the supporting girders which span longitudinally along the tops of the columns. There are no pulins; the wedge frames, which are spaced 8 feet on centers, support the steel roof decking directly.

The wedge frames are shown in an enlarged view in Fig. 10. The characteristic details include the following: The construction is of composite type; that is to say, each frame is partly a wedge beam and

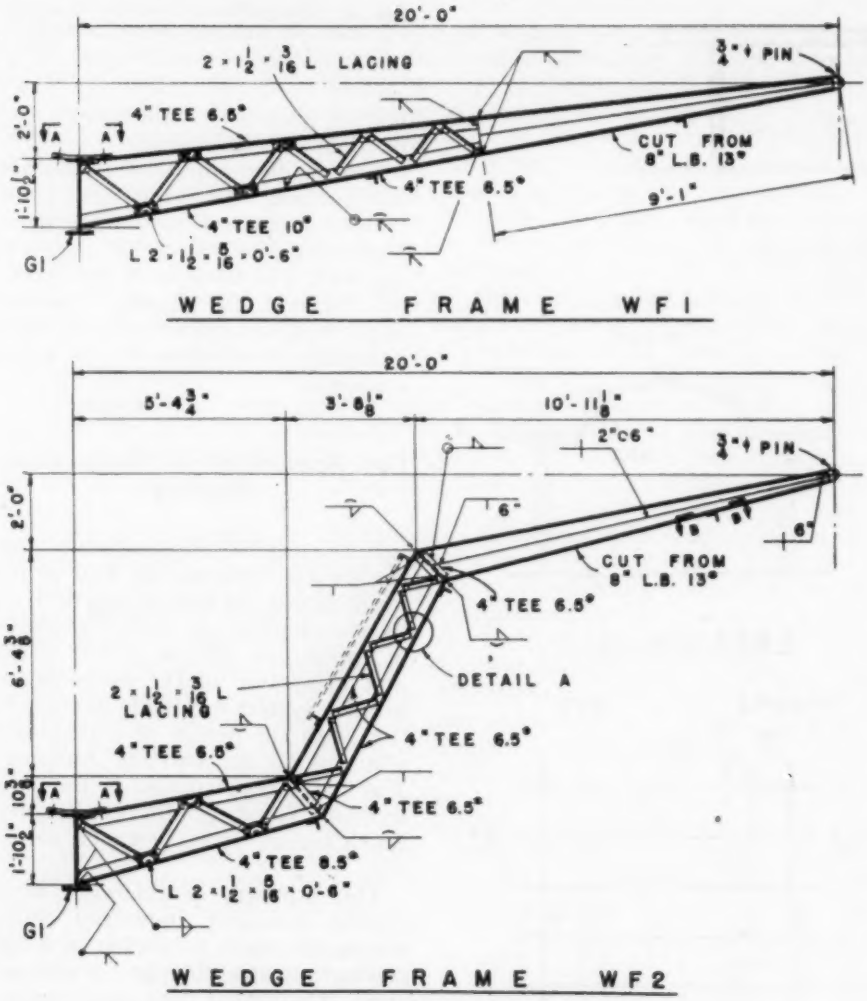

Fig. 10—Typical Wedge Frames for Roof

partly a wedge truss. The low roof frame has a straight taper, varying in depth from 4 in. at the hinge to 1 ft. $10^1/_2$ in. at the support. To provide a roof drainage slope, the axis of the frame is tilted with a rise of 3 ft. at the hinge. The high roof frame is Z shaped. This particular outline conforms to the skylight framing which it supports and also provides the additional operational clearance required along the centers of the bays. The depth of the member varies from 4 in. to 1 ft. $10^1/_2$ in., and the top chords of the end segments are positioned for drainage. Only four types of light sections are used in the assemblies of the frames: these consist of three 8-in. I-beams, weighing 13, 17 and 20 lb., cut to form wedge segments and 4-in. Ts for the chords, and 2-x $1^1/_2$-x $^3/_{16}$-in. angles for the web members.

The girders and columns in the typical bays consist of ordinary rolled I sections without any special features of fabrication. Since the building was to be an addition to an existing structure, it was thought advisable to conform, at least partially, to the old framing outline. In the side bays, however, the end columns are wedge shaped and the wall girders supporting the wedge frames are of built-up box sections, as shown in Details 1 and 3 of Fig. 9.

The assembly and connections details are shown in Figs. 10 and 11. In the assembly of the trussed segments, the web members are placed in one plane and connected to the chords by fillet welds in a lapped arrangement for ease of assembly and positioned welding. The field welding is confined to the connections of the frames to the girders. Prior to field welding, the frames are fastened to the supports and held in position by means of erection bolts. The hinge assembly consists of a $^3/_4$-in. bolt passing through two $^1/_4$-in. thick side plates fillet welded to the end of one frame and a single plate of the same thickness butt welded to the end of the other frame. The bottom chord struts are either welded or bolted, and the steel roof decking is spot welded to the top chords. The girder splices, occurring at 40-ft. intervals, are bolted through slotted connection holes, thus providing small gaps for expansion. The end box girders have a similar splice located in the middle of each span.

Framing Data.—The characteristic data of the framing may be summarized as follows:

Advantages of the New Framing.—The main advantages to be derived from the use of wedge-beam framing are, of course, the savings in the weight of steel and the reduced cost. In this particular application the estimated savings in weight and cost, as compared with the existing framing of conventional type, were 45 and 35%, respectively. The aggregate savings in steel tonnage estimated for the entire project was approximately 860 tons—an impressive saving in these days of critical shortage of steel. Other advantages which are inherent in and incidental to this type of framing include the improved appearance created by the gracefully arching bents, as illustrated in Fig. 9; the elimination of expansion joints and the required supplementary framing and a favorable condition for reduced stresses due to temperature changes

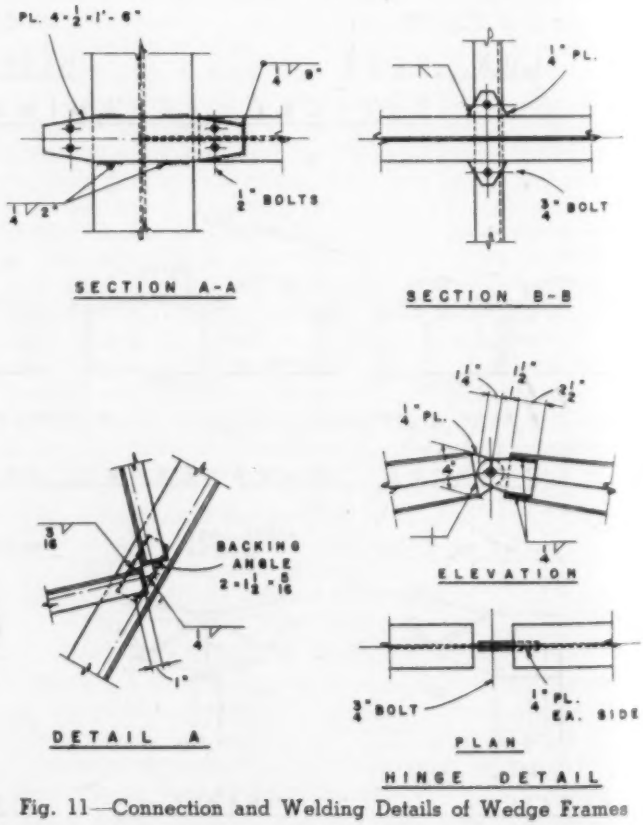

Fig. 11—Connection and Welding Details of Wedge Frames

	Low Roof	High Roof
Frames:		
Number per bay	10	10
Over-all length, each, ft.	20	20
Average weight per ft., lb.	320	386
Total weight per bay, lb.	3200	3860
Girders:		
Number per bay	1	1
Length, each, ft.	40	40
Weight per ft., lb.	76.83	76.83
Total weight per bay, lb.	3073	3073
Columns:		
Number per bay	1	1
Average length, ft.	21.96	21.83
Average weight per ft., lb.	36.02	36.04
Total weight per bay, lb.	790	787
Bracings, splices, etc., lb.	530	2444
Total weight per bay, lb.	7593	10,164
Weight per sq. ft. of floor area, lb.	4.74	6.4
Shop Welding:		
Average size of weld, in.	0.23	0.22
Total weld, length per bay, ft.	178	270
Total weld, electrodes per bay, lb.	32.1	37.2
Weld per ton of steel, lb.	8.45	7.32
Field Welding:		
Average size of weld, in.	0.22	0.20
Total weld, length per bay, ft.	2.25	4.25
Total weld, electrodes per bay, lb.	0.38	0.66
Weld per ton of steel, lb.	0.10	0.13

and settlement or displacement of foundations. It has a further advantage in that the plastic deformations discussed above have only a negligible effect on the stress distribution in the framing. For the designer, it brings a welcome aid in the form of a simplified analysis in design.

Buildings of Tomorrow

The foregoing trends and predictions for future developments are predicated on considerations and design criteria of a world at peace. That these might suffice we may only hope. The possibility of future warfare cannot be, however, ruled out or lightly considered in the planning and design of our buildings of tomorrow. In this respect the grim problem that poses is this: Will it be feasible—economically as well as in an engineering way—to build structures which could withstand tremendous forces from high explosives and atomic blast at rather close range. If this is not feasible, the alternative is then to provide a framing so devised that, by controlling the stress pattern and introducing predetermined paths for cleavage, damage will be minimized and collapse averted. In that task, the "Articulated Wedge-Beam Framing" will prove of special aid. Its adaption for full utilization in future designs will, however, require further studies and some experimentation.

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Electrical Characteristics of the Arc in "Heliarc" Welding*

By H. T. Herbst†

"HELIARC" welding is distinctly different from other methods of arc welding in that the arc is drawn between the workpiece and a virtually nonconsumable tungsten electrode while the electrode, the arc and the weld metal are protected by a sheath of inert gas. The use of an inert gas as a shielding medium gives this process an outstanding advantage since it makes it unnecessary to use flux when welding most of the common metals.

The electric arc in an atmosphere of inert gas has two particular properties that are distinctly different from those that are encountered in the metal arc-welding process, which uses coated electrodes and which transfers metal across the arc. The first of these properties is a cleaning action of the arc when direct-current reverse polarity is used on those metals where oxides are readily formed. The second property associated with an arc established in an atmosphere of inert gas is that the resistance to current flow is considerably higher when the electrode is positive than when the electrode is negative. This latter property creates some special problems in power supply for the Heliarc process.

The purpose of this paper is to explain these characteristics of the arc and to show how they affect the application of the Heliarc welding process.

To establish some common ground for discussing these two properties of an electric arc in an atmosphere of inert gas, there is included a brief review of the Heliarc welding process with a description of the apparatus used and some of the more important applications.

The electrode holder for the tungsten electrode used in Heliarc welding also provides an arrangement to discharge the inert gas around the electrode and the weld. Figure 1 illustrates a typical torch and shows the method of gas distribution, electrode holder and cooling water circulation. In operation, the electrode holder, or torch, is held in much the same manner as the blowpipe in oxy-acetylene welding.

The most important function of the inert gas is to shield the weld metal and prevent contamination by oxygen and nitrogen in the air. As already mentioned, this is responsible for the outstanding advantages of the process, since it makes it unnecessary to use a flux. The fact that no flux is required is of particular advantage in the welding of aluminum. All other fusion welding processes on this metal require a flux for the satisfactory reduction of oxide and considerable work is required to remove all traces of the flux after welding.

The welding of aluminum window sash is shown in Fig. 2. The operator is making a fillet weld using a $^{3}/_{32}$-in. diam. drawn aluminum welding rod and a welding current of 170 amp. alternating current with high frequency stabilization. The process is applied to the fabrication of aluminum beer barrels, shown in Fig. 3. The performed barrel halves are fitted on a mandrel for machine welding the girth seam. The mandrel is then removed through the opening and a forged aluminum bung is manually welded in place as shown in Fig. 4.

The Heliarc process is frequently used with direct current in the fabrication of stainless steel. Figure 5 shows a typical setup for the welding of an edge seam joining the bottom and sides of a stainless steel container. Here a shape weld is being made by employing an oxy-acetylene shape tracing machine.

It was mentioned previously that the cleaning action occurred in direct-current welding with reverse polarity. Let us take a minute to explain the difference between straight polarity and reverse polarity.

In direct-current straight-polarity welding, the electrode is connected to the negative terminal and the work to the positive as shown in Fig. 6. The electron flow is therefore from the electrode to the work. Positively charged gas ions are created in the arc and flow from the work to the electrode. The gas serves only as a shielding medium. Direct current with straight polarity is well

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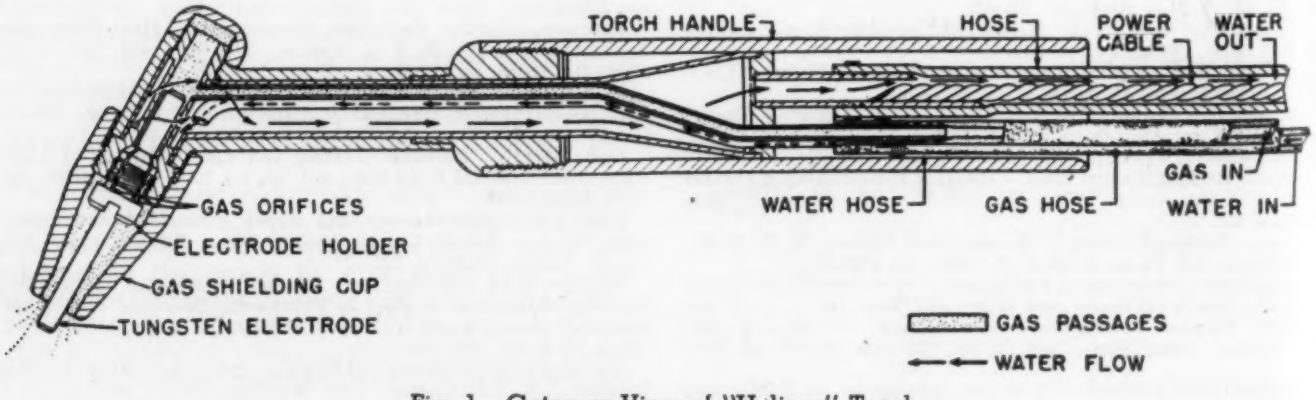

Fig. 1—Cutaway View of "Heliarc" Torch

suited for use in the Heliarc welding process when applied to such metals as stainless steel, carbon steel, copper, some copper alloys and Inconel. This is because the normal oxide coatings of these metals do not interfere with good coalescence in welding.

The contour of the weld produced by direct-current straight polarity is rather deep and narrow, as shown in Fig. 7. The heat liberated by the arc is concentrated in the workpiece and there is relatively little heating of the electrode. When using direct current with straight polarity, an electrode $^1/_{16}$ in. in diameter is sufficient for a welding current of 125 amp.

In direct-current welding with reverse polarity, the electrode is connected to the positive terminal of the welding generator and the workpiece to the negative terminal as shown in Fig. 8. The electron flow is from the work to the electrode. This causes considerably more heating of the electrode. With reverse polarity (electrode positive), it takes a $^1/_4$-in. electrode to carry 125

Fig. 2—Welding Aluminum Window Sash

amp. The contour of the weld as shown in Fig. 9 is shallow and broad.

Welding with direct-current reverse polarity is not generally recommended because a larger sized electrode must be used. In welding the oxide-forming metals, the arc length required is so short that it is difficult to maintain it without fouling the tip. This is particularly evident with aluminum, which is attracted to the electrode. Magnesium, on the other hand, is repelled by the electrode and so, even though the arc length is short, it can be welded by this method.

The Cleaning Action

There is a cleaning action, particularly on certain metals, when the reverse-polarity connection is used. In trying to discover the reason for this cleaning action, we will have to examine what we know and what we believe to be taking place in the electric arc. An electric arc is a passage of electric current through a gas. The gas is ionized and therefore consists of electrons and positively charged ions. The electrons travel from the negative to the positive poles of the arc and the ions proceed in the opposite direction, from the positive to the negative poles of the arc. In the case of reverse-polarity welding, the electrons travel from the workpiece to the electrode while the ions will be traveling from the electrode to the workpiece.

While there is some field for debate as to just what causes the cleaning action, it is a fact that such action

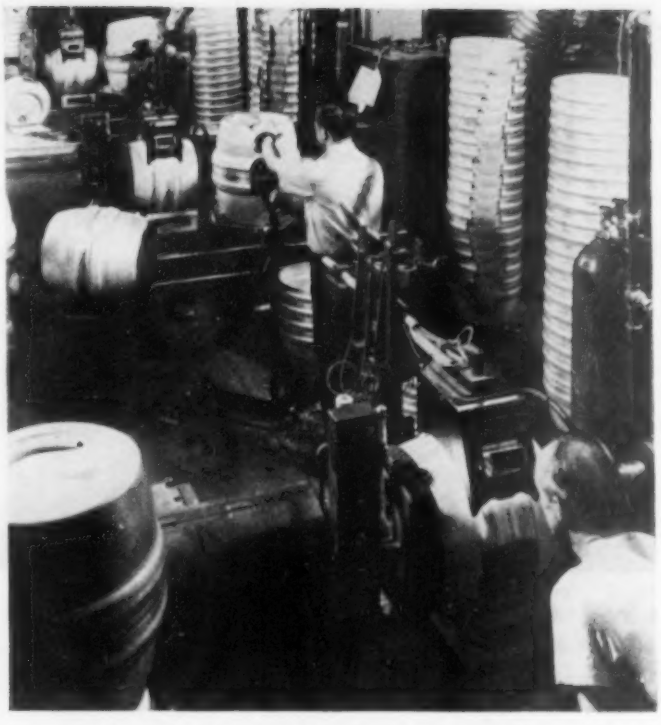

Fig. 3—Machine Welding Aluminum Beer Barrels

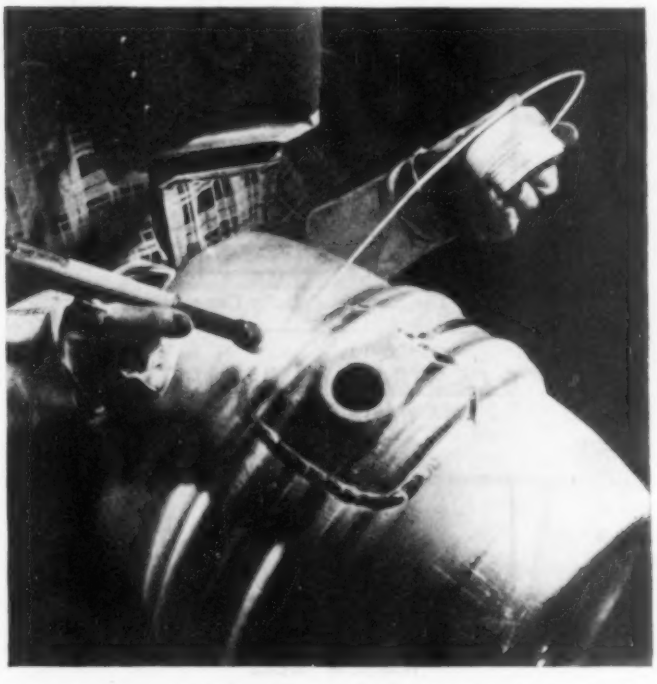

Fig. 4—Manual Welding the Bung to an Aluminum Beer Barrel

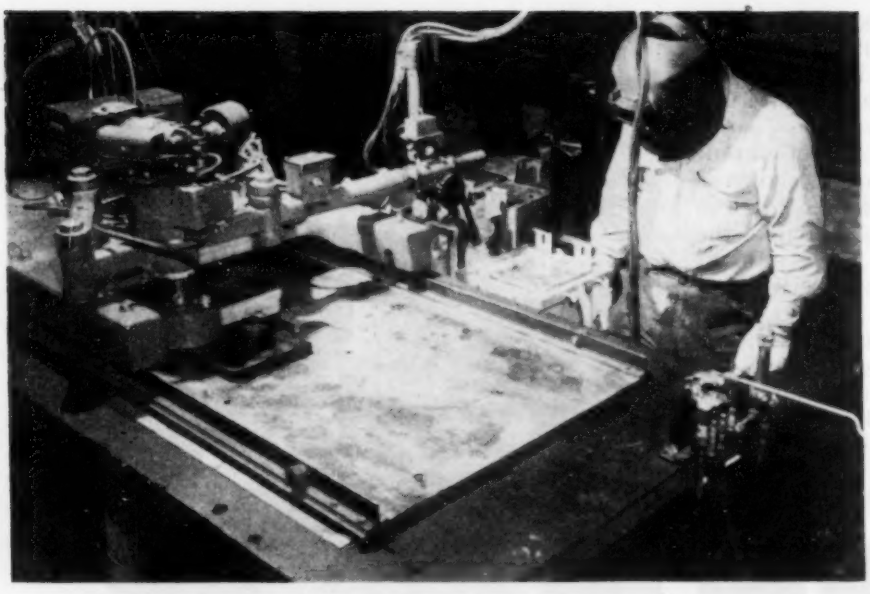

Fig. 5—A Templet Guides the Machine to the Desired Shape in Welding a Stainless Steel Container

does take place with reverse-polarity welding and not with straight-polarity welding. Microscopic study of the cleaned area adjacent to the weld area reveals a condition similar to that produced by sandblasting. It is thought that this is the result of bombardment of the oxide layer by positively charged gas ions in the manner of a miniature sand blast. This is supported in part by reference to the difference in amount of cleaning action obtained when using argon as compared to helium. While there is no noticeable cleaning effect when using helium, the use of argon does provide a marked cleaning effect. It would seem reasonable, then, to attribute the cleaning action to the bombardment principle since the atomic weight of argon is some ten times greater than that of helium.

Characteristics of A.-C. Welding

In welding with alternating current the polarity of the electrode and the workpiece changes at every half cycle of the current. The result is a combination of the characteristics that are peculiar to straight polarity and those attributable to reverse polarity. The depth of melting in the workpiece is less than that obtained with straight polarity but more than would be obtained with reverse polarity. Thus the contour of the weld lies between that of the narrow, deep type produced by staight polarity and the broad, shallow type produced by reverse polarity. A comparison of the three contours is shown in Fig. 10.

The amount of heating of the electrode is between that produced by straight polarity and that produced by reverse polarity. In welding with an alternating current of 125 amp., a $^3/_{32}$-in. diam. electrode is sufficient to withstand melting by the heat produced. The cleaning action present with reverse-polarity direct-current weld-

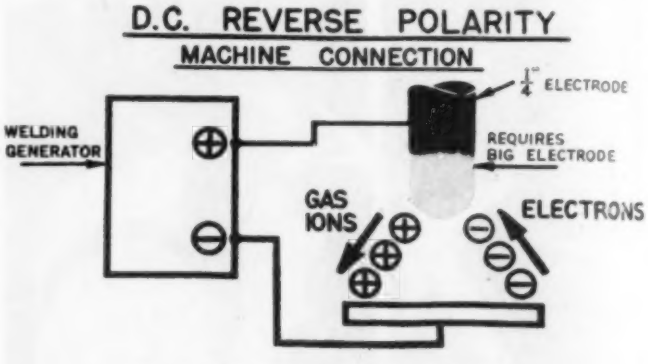

Fig. 8—The Reverse-Polarity Connection

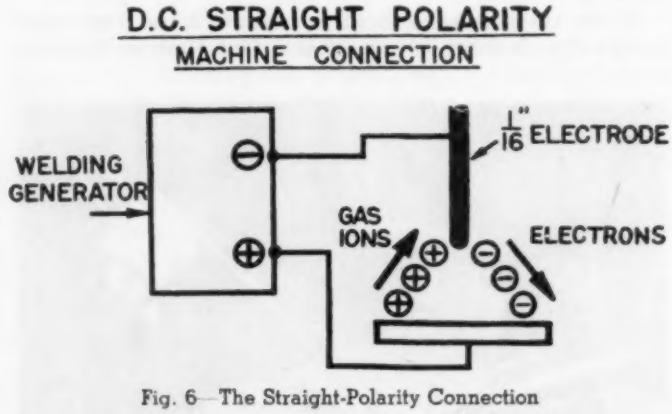

Fig. 6—The Straight-Polarity Connection

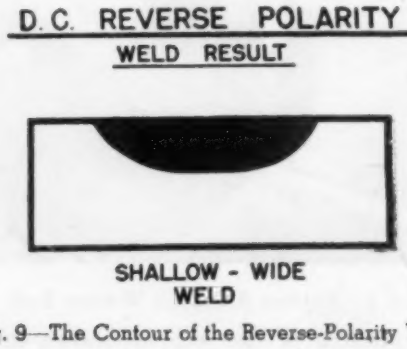

Fig. 9—The Contour of the Reverse-Polarity Weld

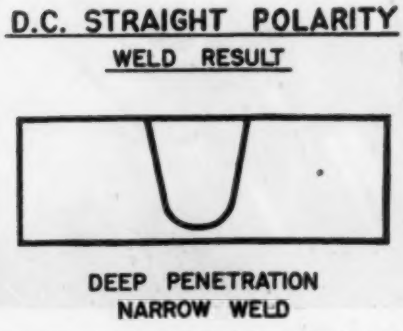

Fig. 7—The Contour of the Straight-Polarity Weld

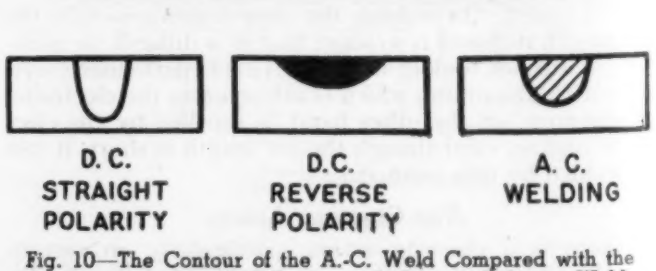

Fig. 10—The Contour of the A.-C. Weld Compared with the Contours of Straight-Polarity and Reverse-Polarity Welds

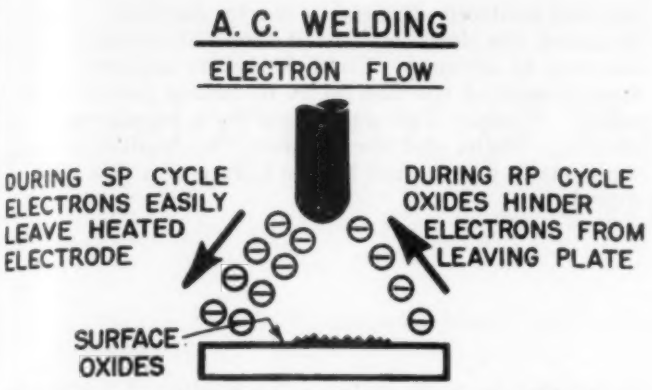

Fig. 11—The Surface Oxides Hinder the Flow of Electrons Leaving the Plate

ing is also present in alternating-current welding, and is sufficient to remove the oxides from those metals that offer particular difficulty (aluminum, magnesium and beryllium copper).

The use of alternating current, however, introduces another problem, namely that of stabilizing the arc. Since the current drops to zero twice in each complete cycle, there must be some means of starting the arc again after it has been extinguished. This can be done by using a transformer that has a high open-circuit voltage, or a high-frequency voltage can be imposed on the regular welding current.

In the first method, the high open-circuit voltage is sufficient to re-establish the arc after the current drops to zero. In the second method, the high-frequency discharge serves to ionize the air gap and provide a ready path for the flow of current.

Problems of the Unbalanced Wave

In an arc in an inert atmosphere between a tungsten electrode and most metals there is a greater resistance to current flow when the electrode is positive than when it is negative, as shown in Fig. 11. The unequal resistance to current flow during the two parts of the alternating-current cycle produces an "unbalanced wave," as shown in Fig. 12. The term "unbalanced wave" is proposed to describe this condition, reserving "rectification" for a condition to be described later. The unbalanced wave shown may be considered a regular a.-c. wave plus a direct-current component. If the method of stabilizing the arc is not fully satisfactory an arc may be maintained with only the occasional loss of the reverse polarity portion of the cycle. Such loss of occasional half cycles is

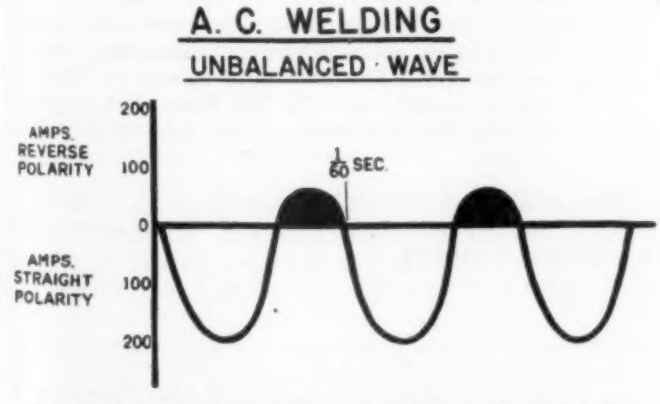

Fig. 12—The Unbalanced Wave Results from Oxide Interference

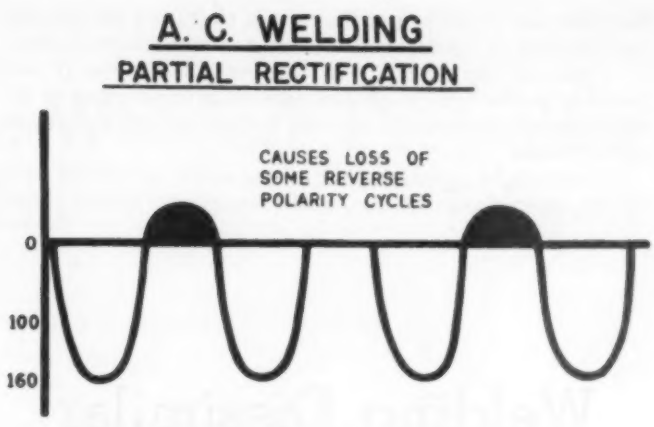

Fig. 13—Partial Rectification of the Unbalanced Wave

illustrated by Fig. 13. The term "partial rectification" is proposed to describe this situation. Where there is no attempt to stabilize the arc, it is possible that no current will flow when the electrode is positive as illustrated in Fig. 14. This is called "complete rectification." When the timing of the high-frequency spark does not coincide with the beginning of the reverse-polarity cycle, only part of each reverse-polarity cycle may be lost and to describe this, the term "incipient rectification" is proposed. This is illustrated in Fig. 15.

In our research laboratories, some motion picture footage was taken at the rate of 3200 frames per second for the purpose of studying the arc in slow motion. When

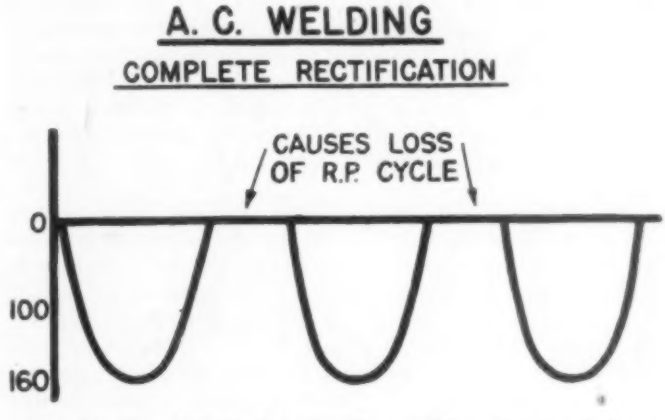

Fig. 14—Complete Rectification Occurs When the Arc Is Not Stabilized

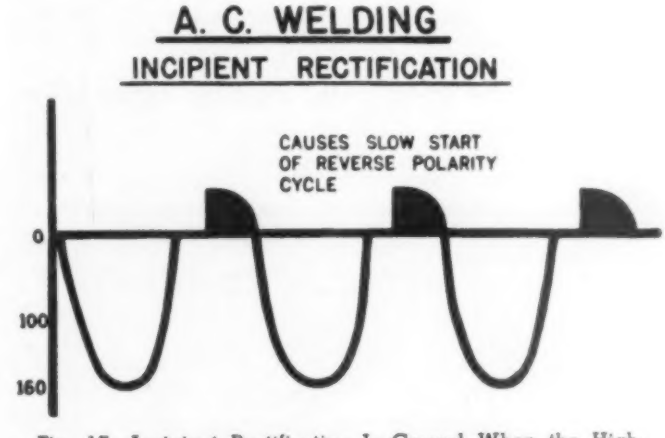

Fig. 15—Incipient Rectification Is Caused When the High-Frequency Spark Is Not Properly Timed

this film was projected at the rate of 16 frames per second, each complete cycle of alternating current lasted about $3\frac{1}{3}$ sec. on the screen. In this length of time it was possible to observe clearly the difference in progress of the weld during the straight and the reverse polarity portions of the cycle.

The straight polarity part of the cycle appeared as a bright, white flash of flame, while the reverse polarity portion was relatively dim and of shorter duration. During the latter, the clean zone ahead of and alongside the weld was seen to advance. Conditions were adjusted during the exposure of the film so as to induce partial rectification. Visually this was shown by a regular series of alternate bright and dim flashes, the regularity being occasionally interrupted by the failure of a dim flash to appear.

Welding Dissimilar Metals*

WELDING dissimilar metals is an important production technique. It ranges from the assembling of large structures, like pressure vessels down to joining the shank and drill portion of a twist drill.

Different portions of a unit frequently require different properties which one metal cannot furnish. For example, when part of a piping system operates at a much higher temperature than the remainder, special alloy steel may be specified for the "hot" portion and less expensive low alloy steel for the "cold" section. Similarly, the inside of a pressure vessel may be subject to severe corrosion that demands a corrosion resistant alloy, whereas plain carbon steel may be satisfactory for the outside of the vessel.[1] Hard facing, too, involves the welding of dissimilar metals. Economy therefore dictates the use of the least expensive materials, but only if the dissimilar metals can be welded satisfactorily to produce joints which are sound, strong and tough, free from cracks and from other defects which may cause early failure in service.

Welding of dissimilar metals may be divided into three classes. In the first group the compositions are all iron base (ferrous). They may vary only slightly in composition, as when joining plain carbon to carbon molybdenum steel (the difference consisting of the 0.5% Mo in the carbon molybdenum steel). On the other hand the base metals may vary considerably as when joining a plain carbon pipe to 12% chromium steel or when joining low alloy steel to high tungsten tool steel.

The second category covers the union of various alloys of nonferrous composition, as well as the pure metals of the nonferrous group which includes copper, aluminum, magnesium, nickel, zinc, etc. Special alloys like Stellite, Hastelloy and Inconel would also fall into this classification.

The third class embraces the joining of ferrous to nonferrous metals, as for instance the welding of nonferrous Monel piping to a steel vessel.

Where economy demands the choice of dissimilar compositions a thorough knowledge of actual service conditions, particularly temperature, stress, abrasion and corrosion, is essential in order to insure that satisfactory materials are selected.

Equally important is choice of the proper welding method and selection of the correct electrode. The weldrod when diluted with the base metal during the welding operation must produce weld metal of desirable properties. In some cases the rod may be similar to one of the compositions being joined; in other cases it is entirely different in composition from either base metal.

Another factor to be considered is the effect of welding temperatures on the "heat-affected" zone in each base metal. This zone is usually of nonuniform grain size after welding. The degree of residual stress in the different metals will also vary considerably. In some cases it is possible to influence the properties of the heat-affected zone by changes in welding procedure—thus higher preheat temperatures will prolong the duration of the various temperature zones and lessen the danger of cracking.[2]

Similarly one must not overlook the possible need for heat treating the welded joint. Treatments will vary from no heat treatment or merely low temperature stress relief to full heat treatment.[3]

Since each metal combination presents a separate problem, metallurgical knowledge and experience should dictate not only the choice of the prescribed welding method but also the exact preheat and postheat procedures to be followed. Some general rules for steels are listed below:

1. Almost any two ferrous metals (steels) may be joined with 25% Cr–20% Ni electrodes, since the latter composition can withstand considerable dilution without affecting weld metal properties.
2. When welding steels, the weldrod may be of the lower alloy composition of the two base metals, provided it yields a strong tough weld.
3. When joining pearlitic or ferritic steel to an austenitic steel, use 25% Cr–20% Ni weldrods.
4. Preheat[3] is of the greatest importance and should always be used wherever dissimilar metals are welded. The minimum should be 200° F. but it should never be less than that required for the most delicate of the two steels to be joined.

The welding of dissimilar metals[4] is so complex a subject that it is not possible to deal with it completely in this brief summary.

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* Reprinted from *Tempil Topics*, Vol. 3, No. 4.

[1] "The Fabrication of Clad Steels," *Tempil Topics*, Vol. 2, No. 5, Nov. 1, 1947.

[2] See Tempil Preheating Chart listing recommended preheat for 79 commercial metals and alloys. Available on request without charge.

[3] Tempilstiks are a convenient way of checking temperatures. Sample Tempil pellets on request.

[4] Spraragen, W., and Rosenthal, D., "Welding of Dissimilar Metals," THE WELDING JOURNAL, 24 (2), Research Suppl., 65-s to 85-s (1945).

Development of Arc-Welded Propeller Hubs*

By Clarence C. Mast,† Paul F. Hackethal† and Douglas W. Hamilton†

THE aircraft propeller, in converting the power of an engine into forward propulsion, is subject to the most rigorous operating conditions imposed upon any flight component. As the blades translate brake horsepower into thrust horsepower, the propeller is subject to bending loads from the resultant effects of thrust, torque fluctuations of the engine, high centrifugal loads of the blades, gyroscopic forces and torsional vibration from engine impulses. These loads must be borne with security by the heart of the propeller, the hub.

The transition to variable-pitch propellers, which occurred about 15 years ago, was preceded by a period in which experience was accumulated with both wood and metal blades detachable from a hub mounted on the engine shaft. In distinction to fixed-pitch propellers, which are generally retained by bolts through the wooden center section and plates mounted on the shaft, detachable or rotatable blades presented serious problems of retention in the hub and required great hub strength if structural security was to be maintained. It was only by developing structurally sound hubs and blade retention systems in addition to practical pitch change mechanisms that the modern, high horsepower, variable-pitch propeller came about.

Early in the experimental work it was found that a propeller scarcely ever broke from steady stress, which was calculable, but generally broke from fatigue due to vibratory stress. Since the latter stress was not easily determined—vibratory stress is still the source of much investigation—enormous safety factors in terms of metal bulk were built into propeller hubs. The finest high-alloy steel forgings obtainable became the generally accepted hub material. These huge forgings represented high cost from start to finish and still do; as in the case of a present high horsepower hub, which as a pierced forgings weighs approximately 300 lb. and is machined down to about 50 lb. Structural integrity of a high order has been achieved though, and retention of blades against centrifugal loads of 75 ton and more is not a problem with the large propellers. It is the effect of this accepted and now traditional method of hub construction for high power absorption on the design of propellers for lower horsepower applications which provides a basis for comparative discussion here.

As the modern light plane has been improved in performance and its horsepower extended into the medium range, the need for variable-pitch propellers has come about in a fashion similar to that of 15 years ago when the high horsepower propellers were initiated. Unfortunately, the experience gained with the large propellers can be used only in a general way because they cannot be scaled down any more than a battleship can be scaled down to provide an armed sloop. A whole new concept of requirements, mechanism and construction has become necessary, primarily to reduce the costs of private planes and accessories so that a wider market may be realized. The first steps taken along this path were not encouraging because the influence of successful fabrication methods, namely forging, of large hubs prompted blind imitation and entailed an impractically high cost.

Fig. 1—A Characteristic Installation of the Model 220 Aeromatic Variable-Pitch Propeller on the 185-Hp. North American Navion

Welding of any nature to fabricate hubs among numerous developers apparently just wasn't considered because of the view that welding would not be strong enough for this very highly stressed application and anyway forging was the only practice in successful use. The one, and notable, exception taken to this view is embodied in the manufacture of the present Aeromatic variable-pitch propeller hub.

Background of the Model 220 Aeromatic

A characteristic installation of the present production Model 220, the hub evolution of which will be described, is shown in Fig. 1 and will serve to clarify the application of the Aeromatic propeller. Fitted to this four-place, 185-hp. private plane, the North American "Navion," the Aeromatic propeller functions automatically, be-

* Data and illustrations from a study submitted to The James F. Lincoln Arc Welding Foundation in its recent $200,000 Design-for-Progress Award Program for reports and advances and improvements made by the applications of arc welding in design, fabrication, construction and maintenance.

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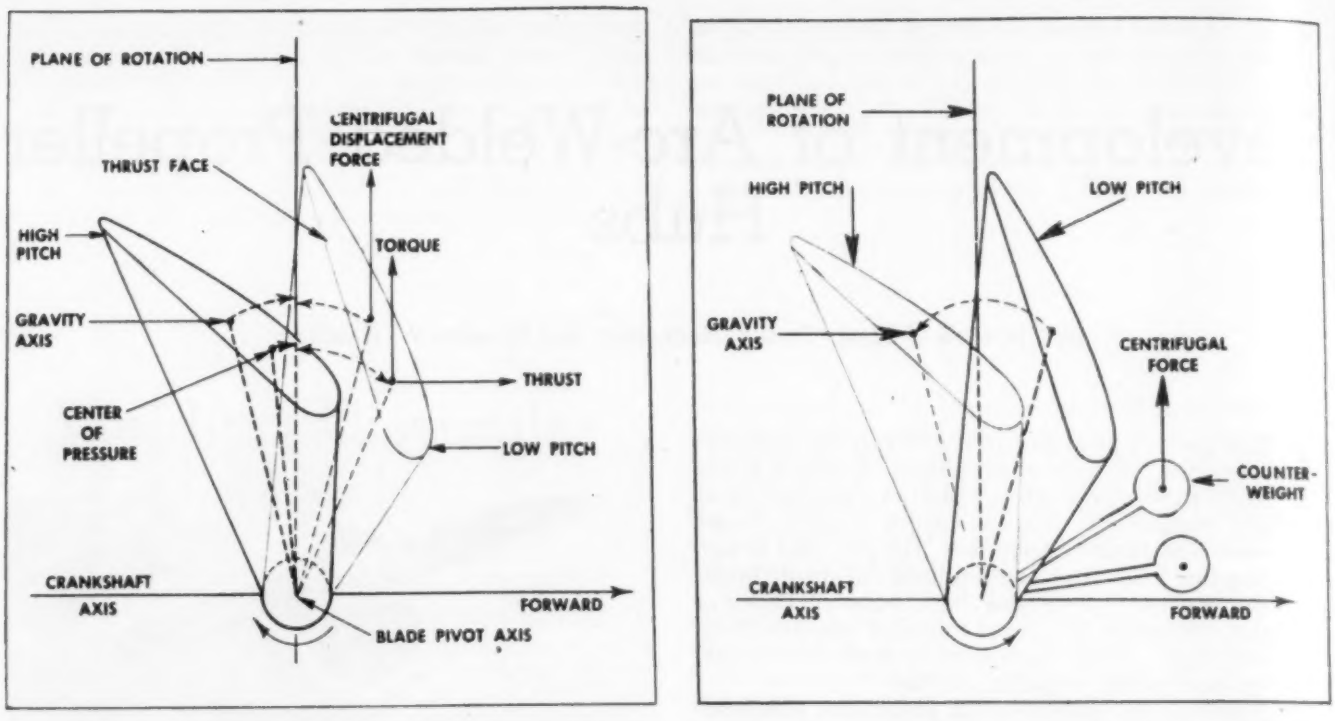

Fig. 2—Schematic Illustration of the Principal Operating Forces of the Aeromatic Propeller Which Provide Automatic Pitch Change Without the Use of an Auxiliary Mechanism

cause of its geometrical configuration, and causes the blades to go to low pitch at take-off and to progressively increase pitch as flight speed increases, with engine speed and power output being regulated without any controls whatsoever. Briefly, the advantages of this function are that full engine horsepower is available at take-off, and safety is thus provided in that a long run is decreased and ascent is rapid. Climbing and cruising speeds are increased because of increasing blade pitch; and engine speed in maneuvers and dives is maintained virtually constant and thus prevents overspeed, which is often dangerous.

The basic feature of the propeller is the geometrical configuration obtained by inclining the blades rearward in the plane of rotation to utilize the aerodynamic thrust moment thus gained to actuate the blades against the mass effects of centrifugal force acting on the blades and of the counterweights clamped around the blade retaining flanges. Briefly, this means that high thrust at take-off rotates the blades to a predetermined low pitch setting and, as flight progresses and thrust decreases, the calculated effects of counterweight and mass centrifugal moments increase blade angles automatically. Figure 2 illustrates the characteristic operating forces of the Aeromatic propeller.

The next steps taken were to reduce weight and cost so that the basically simple mechanism could be introduced to the light plane field at a feasible price. Aluminum alloy hub forgings reduced weight, but their machining costs were as high as steel and, in addition, they would fatigue.

Conventional steel forgings of the higher power propeller type were then used as the hub material for the first production of the 155–200-hp. Model 220 Aeromatic, from 1940 until 1942, when military work required special propeller development. This prior work is compared to the present Model 220 which was redesigned for arc welding and placed in commercial production in 1946.

Hub Development—Model 220

The original steel hub forging, with some preliminary machining completed, is shown in Fig. 3 with the finish machined and ground hub. The forged billet of chrome-molybdenum steel weighed 64.7 lb. and was machined to a finished weight of 17.8 lb.

As to the design characteristics of the finished hub, Fig. 3 shows the large cylindrical socket into which the blade retaining flange and retaining nut fits and the cross bore through the hub center which is splined to fit a particular size engine shaft, in this instance the S.A.E. No. 20. These two principal bores must have an accurate dimensional and high strength relationship because of the retention of the entire centrifugal and bending loads of the blades by the large cylindrical hub socket and the driving torque of the engine by the shaft bore. The other integral features of the hub visible in the illustration are buttress threads for the blade retaining nut, a boss in

Fig. 3—Hub Forging, Partially Machined, Compared to a Finished Hub of the Former Design of the Model 220 Aeromatic Propeller Hub

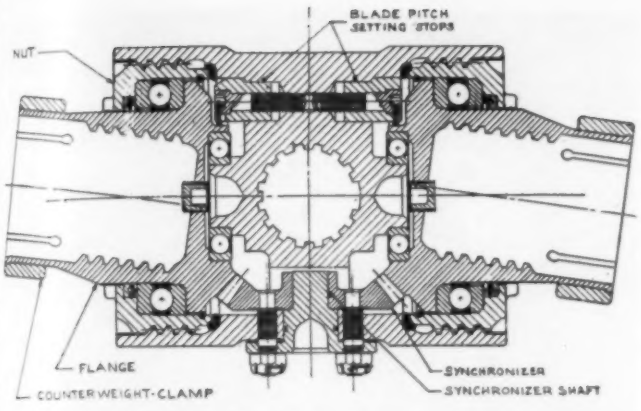

Fig. 4—Cross-Section View of Arrangement of Components in Former, Forged Design Model 220 Aeromatic Propeller Hub

the base of the hub socket to position the blade journal bearing, an aperture through the side of the hub wall for a shaft and a milled slot from one socket to the other to accommodate a gear to synchronize the movement of the blades.

Figure 4, a cross section of the forged steel hub, shows the relative position and nature of the principal and detail parts which will be referred to later with respect to how they were repositioned and fabricated more advantageously with the hub redesigned for welding.

Design for Welding

In the breakdown of the Model 220 hub for welding, the hub barrel and cross tube, shown in Fig. 5, were machined from seamless alloy steel tubing. To expose the pitch setting stops for adjustment, bosses made from bar stock were designed to be welded into holes in the hub barrel wall and threaded for bolts which were externally accessible. The synchronizer shaft, which had previously been bolted to the hub wall, was to be threaded into a boss machined from bar stock and welded to the hub wall. With the cross tube welded into the hub barrel, the boss for positioning the inner journal bearing, also machined from bar stock, could be welded to the cross tube. To balance the assembly a simple piece of curved plate would be welded to the inner hub wall; this would counteract the effect of the location on one side of the synchronizer boss, gear and shaft. Threading the inner lip of the hub barrel for a retaining nut was eliminated by use of an internal expanding snap ring in a groove in the hub wall. The manufacture of these parts was indeed straightforward and far less costly than a forging and its machining. Weight reduction of a substantial order was possible because superfluous metal, which could not be removed economically from the forgings, if at all, was not present with the tubular composition.

It now remained to secure all of these parts quickly and inexpensively. It may be admitted at this juncture that the quantity of empirical work exceeded that of the theoretical for a considerable experimental period because of the new ground being covered. First copper furnace brazing was tested thoroughly because of the speed offered and clean bond obtained. However, distortion in heat treating due to the unequal sectional areas would rupture the bond of the pitch stop bosses in the hub wall and the cross tube in one or both sides of the wall. The wholly unpredictable results of this method of joining the parts soon indicated its unsuitability. Arc welding was tried next; but becuase of the wall thickness, $^3/_8$ in., of the experimental units, a J-groove at the edge of the hub cross tube bore was included to give sufficient penetration area. Five passes with an E-10010 electrode $^3/_{16}$ in. in diameter were believed necessary to secure a good weld. The machining of the groove, time required for multiple passes and the subsequent grinding relegated this system of welding to the background, momentarily. Under-bead cracks in the built-up weld were considered the only serious structural defects.

Atomic hydrogen welding was tried next to eliminate the groove, multiple passes and grinding. This method produced a satisfactory weld of good penetration, and it did not require grinding. However, welding a single bead around the cross tube took as much time as the previous five arc weld passes. In addition, working inside the hub bore with the atomic-hydrogen electrodes was unwieldy and consumed more time. At this stage in the experimental work a comprehensive stress analysis to reduce weight indicated that much thinner walls would be entirely satisfactory. The design based upon this analysis and considerable test work possessed walls only half as thick as previously, or $^3/_{16}$ in. thick. This indicated that arc welding could now be used with better results. When the new design was arc welded, the thinner section structure permitted deposit of a good penetration bead at one pass around the cross tube and barrel and around the inserted bosses; and the previous J-groove was no longer needed. Electrodes for welding high- and low-alloy steels with different current values were tested extensively to determine the practice in use today. The type and conditions of the steel used also had an important bearing upon attaining success and establishing the practice in use today.

The hub barrel and cross tube of the present design are machined from electric furnace, aircraft quality seamless steel tubing, S.A.E. 4130, purchased in a finish annealed condition. Both hot-finished and cold-drawn tubes have been welded with success. The bearing boss which is welded to the cross tube is made from 4130 steel bar stock and the synchronizer boss, pitch stop bosses and balance weight are all of S.A.E. 1020 analysis, normalized. These parts, designated and in relative position as shown in Fig. 6, may be referred to in following the welding sequence.

Welding Steps

The cross tube is positioned through holes bored in the hub barrel in a jig which also holds the balance weight against the inner wall of the hub and the synchronizer boss in position in the hub wall. These components are then atomic-hydrogen tack welded, which makes smooth shallow tacks that may be passed over with the arc later with no perceptible rise or slag to contend with. The tacked assembly is preheated in a furnace to between

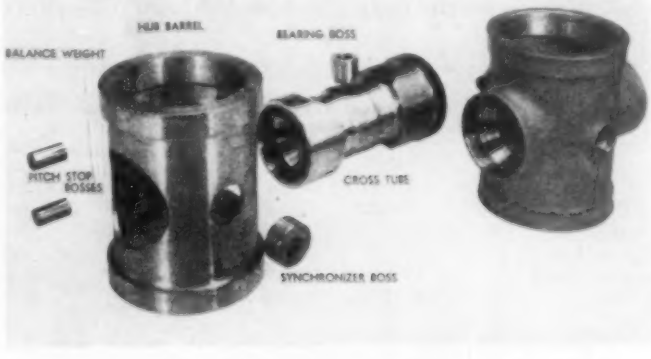

Fig. 5—Components of the Present, Arc-Welded Design of the Model 220 Propeller Hub and the Welded Hub

500–600° F., then placed in a positioning jig. A fillet weld is made first at the junction of the cross tube and hub wall, externally, with a 5/32-in. diam. E-10010 electrode, using approximately 130 amp. current. Upon completion of this preliminary welding, the hub is immediately normalized for 30 min. at 1500° F. and allowed to cool in still air. It is then shot blasted with angular shot, the welds ground, the holes drilled in the hub wall to receive the pitch stop bosses and the transverse hole in the cross tube is reamed to receive the bearing boss. This intermediate step of machining has been found necessary so that stresses in the welds of smaller parts yet to be added are minimized. The stop bolt bosses are now fitted into the holes in the hub wall and atomic hydrogen tacked in a jig. The bearing bosses are pressed into the cross tube and the hub is again preheated to 500–600° F. Welding is accomplished with 1/8-in. diam. electrodes, a fillet bead being laid in at one pass around each boss on the external surface of the hub wall. The penetration of the weld at the bosses is not required to be as great as that of the welds at either end of the cross tube because they do not carry appreciable loads. The cross tube to hub barrel weld, however, does carry substantial shear stress due to torque and must be entirely free from defects which torsional vibration could aggravate.

Following the final welding, the hub is again normalized and heat treated. It is quenched in oil at 1550° F. and drawn at 1020° F. for four hours. After final shot blasting the hub is Brinell tested for a 250–276 reading and given a ferromagnetic inspection check before grinding and final machining. Grinding irregular or complicated shapes can be quite costly unless reduced to the minimum necessary. Fortunately the tubular hub components receive a good turned finish initially so only the weld bead needs blending attention. A splatter-proof coating reduces adherence of weld particles and subsequent shot blasting removes the particles that do stick. Slag is also removed by the shot blast, and thus hand removal is eliminated for any purposes other than exposing the end of a bead for continuance of welding or for inspection of a weld. Welds are ground with coated wheels the blended area extending approximately 3/8 in. on either side of the weld. After grinding, the hub is thoroughly inspected by the wet magnetic method to determine existence of cracks, slag inclusions or excessive porosity. It may be observed here that the welding technique of experienced operators is so highly developed that rejections are unbelievably low and cannot be compared to machining rejections in quantity. Jigs, of arc-welded construction, are freely mounted and counterbalanced so they may be swiveled by a light touch and have no tendency to produce irregular motion. Heavy universal jigs were found to lag or jerk from the friction of weight and sheer inertia. This prevented steady rotation and smooth tilting while welding was in process. As the time figures will show, the welding of this hub, while of a precise and critical nature, has been reduced to a repetitive technique that may be conservatively considered to have no known parallel in its class.

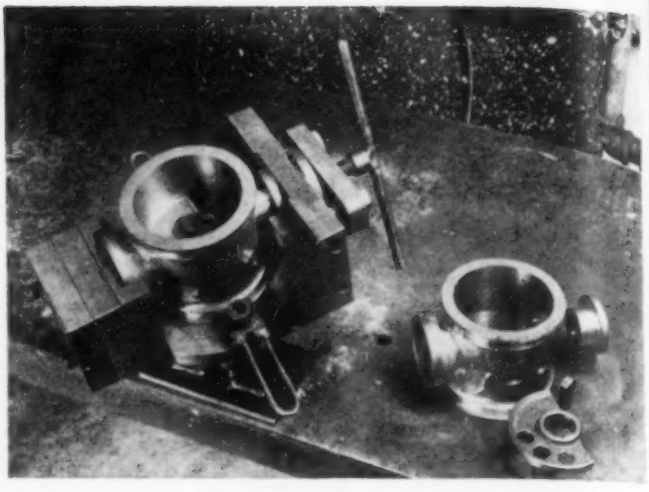

Fig. 6—Hub Barrel and Mounting Tube Subassembly After Welding and Grinding in Locating Jig Ready for Tacking. (Parts to Be Tacked Are Shown in Exploded Position Beside the Jig)

Cost Considerations

The cost and weight data are consolidated in Table 1, in a manner to show the exact extent of savings realize with arc welding versus forging. Total figures are given in all instances because details vary and are superfluous for this study. The 42.8% cost reduction determines the price and extent of the market more than any other factor. However, the weight saving of 31.5% is almost equally important because of its influence on total aircraft weight, hence performance. In other manufacturing fields the weight factor seldom assumes as great an importance as it does in aircraft construction. Weight reduction can be converted to monetary gain with fair ease. This conversion, so often cited in airline studies, can be applied to the personal airplane in terms of increased performance without the increased cost of greater horsepower. Indirect benefits, such as greater baggage capacity, become factors of utility which are competitive points within the industry but determinants of appeal to potential customers.

Conclusions

Summation of the over-all benefits of production arc welding of Aeromatic propeller hubs is best expressed by the fact that the company will save in excess of $205,000 on direct labor and raw material this year at the present rate of production. Savings last year were proportionate

Table 1—Cost and Weight Data Forged vs. Welded Model 220 Propeller Hub—Repetitive Production

	Raw Material Weight	Raw Material Cost	Standard Machine Time Man-Hours	Direct Labor Cost	Total Cost (Including Burden)	Finished Hub Weight
Forged hub	64.7 lb.	$10.36	16.4 hr.	$20.50	$61.61	17.8 lb.
Welded hub	47.1*	6.80†	9.1‡	11.38	35.25	12.2
Gross savings	17.6	3.56	7.3	9.12	26.36	5.6
Savings	27.2%	34.4%	44.5%	44.5%	42.8%	31.5%

* Includes 1.2-lb. Planeweld No. 1.
† Includes $0.14 welding electrode cost.
‡ Includes 0.98 hr. welding time.

on the smaller rate of production entailed in the introductory period.

From the broader aspect, it must be considered that the very presence of the propeller on the market is in no small part due to the fact that it can be offered at a reasonable sum. Pilot customers and light aircraft manufacturers could dispense with the advantages of a variable-pitch propeller in all but the cases where the aircraft's safe operation depended upon it if the price was out of reason. As it is, fixed-pitch propeller equipment is being replaced with the Aeromatic in a substantial quantity as private flyers are discovering that quicker, i.e., safer take-offs, more rapid rates of climb and higher cruising speeds are produced by the propeller's automatic pitch change and control of engine power output.

The adventure in kinematics which produced the only successful propeller to operate solely because of harnessing natural physical forces was considered unconventional until the propeller performed with accuracy and dependability and reached a state of demand and production greater than that of all other small variable-pitch propellers combined. Viewed from a vantage point other than ours, the retention of a propeller blade against tons of centrifugal force, by a snap ring instead of the traditional threaded nut, could be considered unorthodox. Thus the whole propeller is unconventional by previous standards, but none of its features are technical whims. Dispensing with controls by the use of natural forces provides a reliable mechanism not dependent upon auxiliary power or complicated mechanisms and eliminates the cost of these items. Arc welding the principal component permits use of tubes, drop forgings and simple machinings and thus a cost reduction impossible with any other practical process is attained. The flexibility of manufacture afforded by arc welding permits the disposition of all adjustment devices externally, so the inner works need not be disturbed by minor adjustments and subsequent minor design changes can be made with no appreciable tooling cost. Summed up, it seems profitable to develop machinery along unconventional lines if the judgment of convention is based solely upon whether or not it has ever been done before.

It is hoped that our successful application of arc welding to a flight component, the strength requirements of which most aircraft engineers respect, will dispel any doubts as to strength characteristics of arc welding and impress fellow light aircraft manufacturers how to make savings possible and selling price reductions permissible. For it is only with this latter step that we will realize an ever wider acceptance of the personal aircraft.

High-Purity Helium Saves Money on Aluminum Welds

By William A. Mays*

THE Bureau of Mines has announced that its entire production of helium is to be known as "welding-grade" helium and will have a purity of 99.8% or better. With this announcement, industry comes one step nearer to having at its command a single gas which is ideal for all of the various phases of shielded arc welding.

For the past 18 years, the production of helium by the Bureau of Mines has been confined chiefly to that having a purity of 98.2%, and this has been deemed quite satisfactory for use in lighter-than-air craft and for the various medicinal uses. Also, the former standard was satisfactory when used in connection with shielded arc welding of such metals as magnesium and stainless steel. It did not give entirely satisfactory performance, however, in connection with the welding of aluminum.

Those who have had an opportunity to see aluminum welds made by the shielded arc welding process using the welding-grade helium now regularly supplied have been very enthusiastic over the results. They have been impressed because the welds themselves are highly satisfactory and because the use of helium in the shielded arc process for welding aluminum promises to reduce over-all costs.

In using welding-grade helium in welding aluminum, it has been found that one-fifth to one-third more helium is normally required than when using argon. It should be noted, however, that by using helium, greater penetration is obtained and much faster welding speeds are possible than with argon so that, on many jobs, the over-all cost per inch of weld is quite favorable for the use of helium as a shielding medium.

Before conversion of its helium plant for the production of welding-grade helium, the Bureau of Mines carried on extensive surveys to ascertain the effects of impurity. These studies resulted from the desire to supply the best possible inert gas for welding purposes. It was found that, to make entirely satisfactory welds on aluminum, the helium should be as free as possible from hydrogen, nitrogen, water vapor, and oil vapor.

Many fabricators using the shielded arc process for the fabrication of equipment by welding have been contacted, and many of them were found to have the idea that if they did not obtain at once a satisfactory weld using the shielded arc process, the answer was to increase the flow of inert gas. In most instances, this is a mistaken idea. Increasing the gas flow above a reasonable maximum will not improve the condition of the weld; but, on the contrary, excessive amounts of gas may produce porous welds.

When welding-grade helium is used in the inert arc process, it can produce aluminum welds having a bright surface condition, excellent fusion and penetration are obtained and the gas used is not excessive. As a concrete example, the Bureau regularly demonstrates the production of corner welds on $^1/_8$-in. aluminum using 11 to 12 liters of welding-grade helium per minute and welding at the rate of 25 in. per minute. Comparable welds using argon require approximately 8 liters per minute, but slower welding speeds are necessary to obtain good penetration.

Welding-grade helium is now obtainable through compressed-gas distributors in practically every part of the country. The Bureau is confident that this helium will be satisfactory for most of the requirements of the inert-gas welding industry for welding aluminum, magnesium, stainless steel, Everdur, and many other hard-to-weld metals.

The Bureau of Mines plans to publish a series of articles on the use of helium in inert arc gas welding, in which technical data showing microscopic cross sections of welds, tensile strength, and X-ray photographs will be included.

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Modern Projection Welding*

By Robert A. Reich†

PROJECTION welding is a method of resistance welding whereby the current flow and heating during the welding operation are localized at predetermined points called "projections" or "embossments." There is no faster, more economical or stronger method of attaching fasteners than by projection welding and its increased use has been phenomenal within the past ten years.

Fasteners provide the means by which the component parts of an assembly are held together. When determining whether a job should be projection welded the following factors should be considered:

1. The materials used must be suitable for projection welding.
2. The work to be welded must be so designed and of the size to enable it to be carried to the welder.
3. The quantity must be large enough to warrant the cost of tooling up.
4. Suitable welding equipment must be available.

Consider the fastener applications before starting the layout on any new or original design. Many times the designer may make a slight change in a design to accommodate a standard fastener while the job is still on the board. In some cases it has been necessary to redesign a complete product and even have stamping or forming dies rebuilt in order to use a certain fastener. If proper thought had been given the problem at the start of the layout all this unnecessary expense could have been avoided.

One of the most important advantages of projection welding has been the economy of attaching parts of irregular shape to sheet metal which could not be spot welded. A few special fasteners of this type which are used extensively are shown in Fig. 1. All of these designs are suitable for multiple welding except items with ring-type projections.

Many times, three or four products of the same design can be welded in one operation and, consequently, the cost of welding is greatly reduced.

When a design includes fasteners which are to be projection welded it is very important to set up the correct material specifications. Many materials may be suitable for projection welding but are difficult or impossible to upset and cold-work. The following materials are well suited in both respects:

Low Carbon Steel (Carbon 0.20 max.)
Naval Brass
Monel
Stainless Steel (18–8)

For example, it is much better to specify a fastener to be made in low-carbon steel with the diameter or cross-sectional area of the product increased to obtain the same strength as the product would have if made from No. 1035 or No. 1045 steel. Many times, when welding steel over 0.20 carbon it is necessary to preheat before welding or use a postheat after welding in order to reduce the cooling rate. Sudden cooling of a welded section will result in very brittle welds that are apt to fail under strain. Many dissimilar metals may be welded together; in fact all the materials listed above as being suitable for projection welded fasteners may be welded using any combination of these materials.

In respect to finish specifications on fasteners, the optimum welds are always made on products furnished in bright finish. Bright finish means a clean surface without scale or other foreign materials, such as platings, etc. Quite often a completed assembly may be too large to plate economically in which case it is much better to have the fastener and sheet plated before they are welded. Zinc (Electro-galvanizing) is the best plating and does not materially affect the welding operation and good, strong welds can be obtained.

Weld products should never be specified with Parkerized or Black Oil finish (annealed finish) as these finishes are very poor conductors of electricity, and if used it would be necessary to burn through the finish on the first

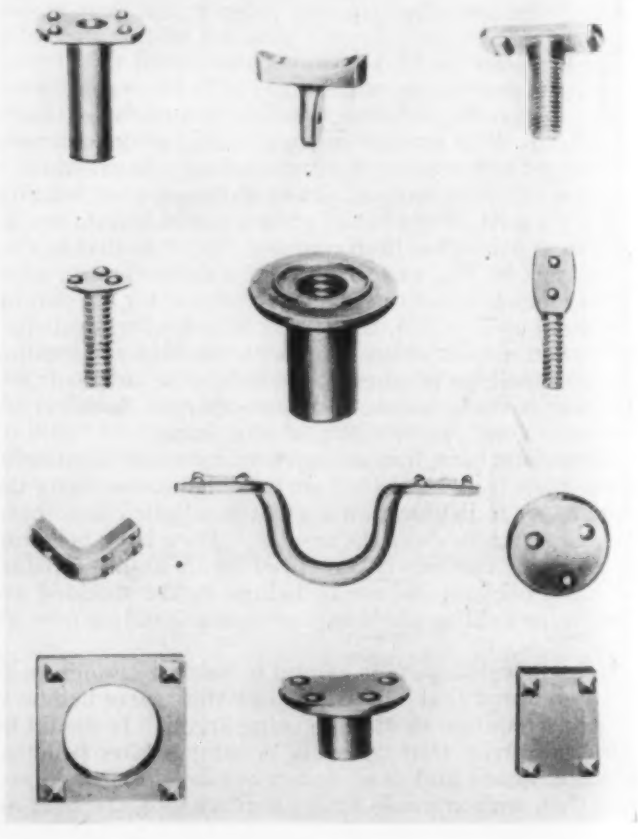

Fig. 1

* Contributed by the Machine Design Division for presentation at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 4, 1948, of The American Society of Mechanical Engineers.

† Chief Engineer, The Ohio Nut & Bolt Co., Berea, Ohio.

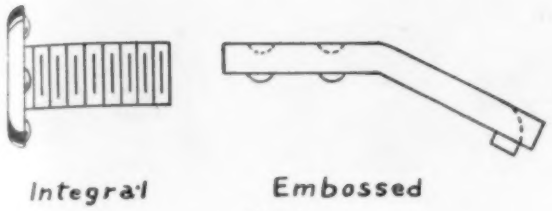

Fig. 2

impulse and do the actual welding on the succeeding impulses. In cases of this type it would be necessary to use a pulsating timer which automatically controls the number of impulses and cycles during the "on" and "off" periods.

In designing the actual fastener it is important to bear in mind the function it is to perform. All other factors are secondary, such as weldability, appearance, etc., but it is also imperative that the item be produced economically in production quantities. It is advisable to consult the manufacturer of the fastener as in many cases he will be able to offer helpful suggestions which will often reduce the cost of the article and make it more satisfactory in its bonding capacity.

When presenting the problem to a fastener manufacturer there are three important factors which must be decided upon:

1. Thickness of sheet metal to which fastener is to be welded.
2. Type or analysis of material to be used.
3. All important or limiting dimensions must be given.

There are several basic principles which all designers who are interested in projection welding should know even though the final responsibility of design of the fastener may rest with the fastener manufacturer.

Whenever possible an integral projection is recommended. The embossed projection is used for many sheet metal fasteners but, as shown in Fig. 2, the embossing leaves a weak section in the parent metal adjacent to the projection. During the welding operation the projection has a tendency to collapse and flow back into the sheet.

There are many types of projections, and all will result in good welds if the right projection is used for the job.

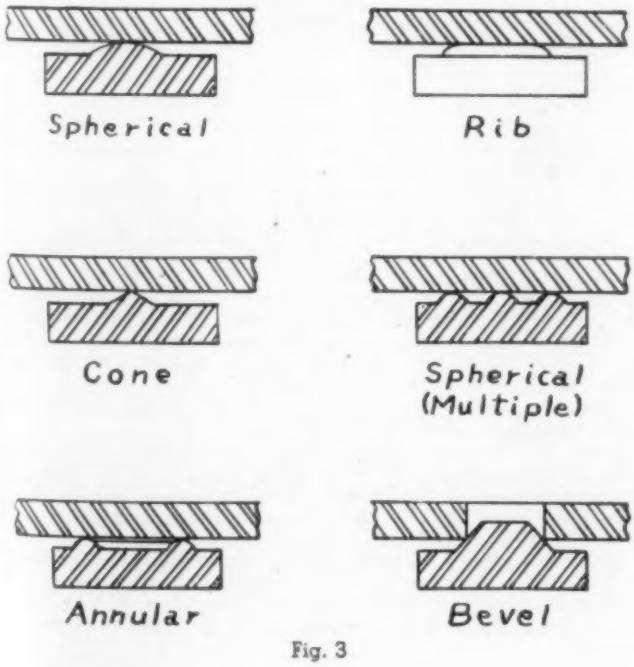

Fig. 3

Figure 3 illustrates the most commonly used projections for fasteners.

Three projections provide a "Three Point Bearing" and should be specified whenever possible. In cases where it is impossible to use three projections, it is much better to have one or two than a number exceeding three. If more than three projections are used it is very difficult to obtain uniform electrical contact on all the projections; consequently, some of the projections will not be welded and the resulting strength of the total welded area, in some cases, may only be 50% of the estimated strength.

The rib, single spherical and cone projections are used when welding to stock over 0.093 in. thick, the other projections are used for welding to stock under 0.093 in. thick. The ring-type projections are used when water or gastight welds are required. The ring projection is ideally suited for sealed welds but requires good welding

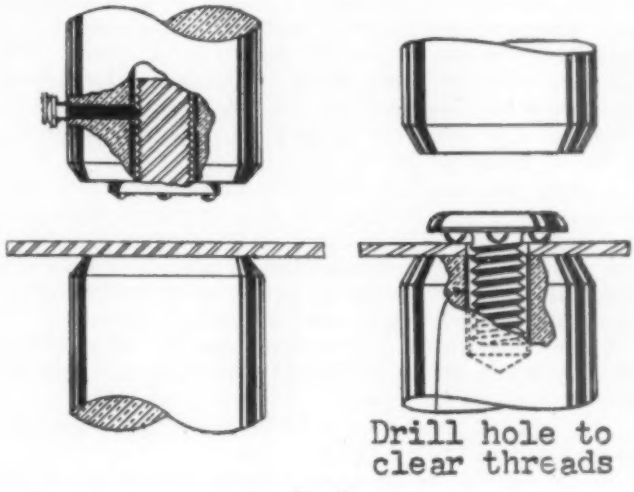

Fig. 4

equipment. A press-type welder with modern electronic controls is essential.

The projection welder is one of the most flexible machines being made today. To change a job, only electrodes and fixture for holding the work are replaced. The design of the electrode is based on the type of product to be welded, material specifications and number of welds being made. In high production welding it is advisable to use a hard alloy facing approximately $^1/_4$ in. thick which can be brazed to the copper base electrode. The facing material should have a minimum hardness of 90° Rockwell "B" and an electrical conductivity of not less than 30% that of copper. In multiple welding, individual electrodes should be inserted in a copper die block to enable each electrode to be removed for refacing or replacing. It is also an advantage in making adjustments, in order to obtain uniform contact on each product.

When small sheet metal stampings are to be welded it is best to design a fixture to hold and locate the work during the welding operation. The same principle applies to making jigs for welding that would be used for any production job on punch press, milling machine, etc. All holding devices should be well insulated and conductors kept out of the loop as much as possible. Figures 4 and 5 illustrate typical electrode setups for welding fasteners.

When welding to sheet metal $^1/_8$ in. and thinner, the 75-kva. welder is one of the most practical and economical machines. It has a wide range of capacity and can be used efficiently on many small jobs where only the output of a 10 to 15 kva. is required. It is impossible to set up a chart on the complete welding setup required to weld

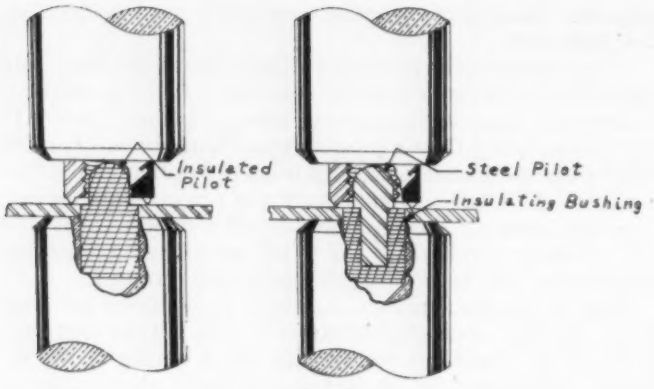

Fig. 5

fasteners as there are so many variables present, such as thickness of sheet metal to which fasteners will be attached, mechanical condition of welder, type of material, etc. In most cases the weld should be made in as short a period as possible, preferably from 5 to 40 cycles. The pressure will vary from 200 to 2000 lb. total electrode pressure depending upon the job. A good weld has been obtained only when the projections pull metal from the sheet as illustrated in Fig. 6.

During the welding operation there should be very little spitting or sparking. If this condition does arise the current should be reduced as the current density is too great in the projection and is actually exploding. When the current is reduced it may be necessary to increase the time to compensate for the reduced heat.

Figure 7 illustrates several applications of weld fasteners in which tremendous savings were made and production was greatly increased.

The following factors should be given due consideration when projection welding:

1. A parallel relationship should always be maintained between opposing faces of electrodes.

2. Electrodes should be water cooled and the water should flow as close to the tips as possible. The inlet water tube should be less than $^1/_4$ in. inside diameter.

3. The electrode should be located on the center line of the pressure application to eliminate wear on the machine and will also insure more uniform welds.

4. A coat of cup grease can be applied to both dies when new. This will minimize the sticking of work to the dies.

5. The throat area should always be kept at a minimum. The larger the throat area, the greater the reactance that must be overcome.

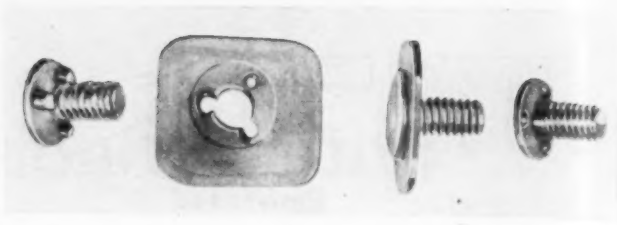

Fig. 6

6. All clamps and pins used for locating work must be insulated and all moving devices for locating work must be protected from flashing. This is very important on high production welding as flashing could get across the insulated pins causing a direct electrical short.

In spite of the great progress made in the resistance welding field, the possibilities are still unlimited and many improved methods will be developed due to the ever-increasing demands placed upon the welding field as a whole.

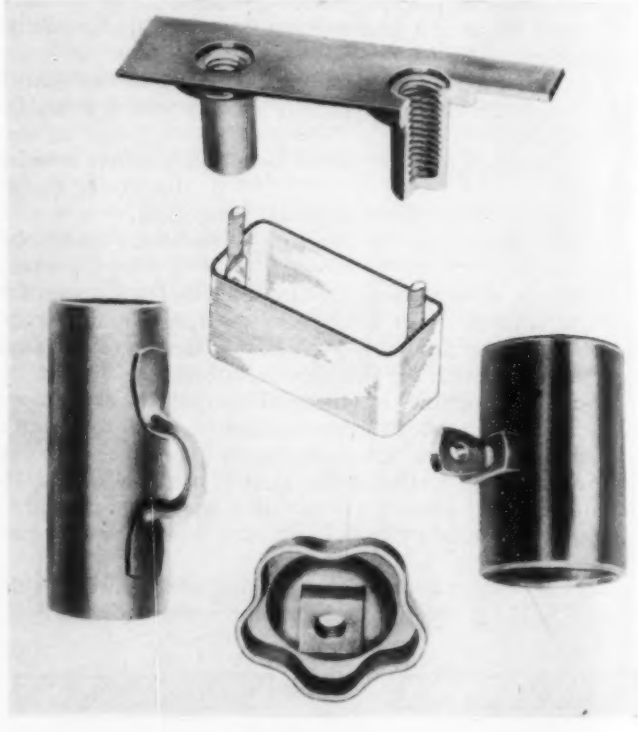

Fig. 7

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(*Continued from page 599*)

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Spot Welding of Mild Steel in Production*

By N. E. Wheeler†

Article covers design, control, operator training, machine maintenance and inspection.

PRODUCTION spot welding can be very disappointing either because of failure in service or in higher over-all cost than is necessary with a good systematic control of the process. How many times have you been faced with statements such as, "We don't trust spot welds," or "It is impossible to determine whether a spot weld is good or not by looking at the outside surface," or "It is necessary to throw sparks six feet in order to be sure of having a good weld." Spot welding has acquired a questionable reputation for service in the minds of some designing engineers, inspectors and users. Because of this, many designers will specify ten spot welds where two would be adequate or add a few rivets or bolts to a spot-welded joint to secure it in case the spot welds should fail. Many typical spot-weld applications are avoided due to lack of confidence in spot welds. It is the responsibility of those concerned with production spot welding to take steps to improve the quality and lower the production cost in order to inspire confidence in the process. Experience has shown that spot welds properly made will exhibit good and consistent physical properties, but this is difficult to explain in the face of field failures and poor-appearing production welds.

During and since the war, we found that we could produce dependable spot welds by exercising the proper control. One of the most highly stressed members on the 6 x 6 military truck was the completely spot-welded assembly shown in Fig. 1. We found that by pulling tensile coupons 3 or 4 times during a shift, we could maintain weld strengths above our standard requirement. As a result, there were no reported spot weld failures on this assembly in the field.

Briefly, I will go through the steps that should be taken in systematizing spot welding. We will start with design because the success of a spot welded assembly can too often be traced back to this point. The draftsman should have available a list of spot-welding design rules and tables to follow. This should include:

1. A table giving data on:
   - (*a*) Desirable flange widths.
   - (*b*) Optimum spacing of spots.
   - (*c*) Weld strengths.
2. Design data:
   - (*a*) Metal thickness ratios, should not exceed $3\frac{1}{2}$ to 1.
   - (*b*) Strength values listed are in shear and in tension only 25% of values can be expected.
   - (*c*) Where torsional load is involved, at least 2 spot welds should be employed.
   - (*d*) Characteristics and general geometry of spot-welding equipment available.
   - (*e*) The part should be designed if possible so that holders can be used in the vertical position.
   - (*f*) Illustrations of good and bad joint designs.
   - (*g*) Charts showing spot weldable materials and combinations.

The machine operator and the person responsible for setting up the machine should be trained in the fundamentals of spot welding. A good method for accomplishing this would be to prepare a booklet explaining the operation of a spot welder in a language that he can understand, using animated characters and simple diagrams to insure his interest and understanding. Include in this booklet other information that you would like to have the operator know such as machine care, placing of spot welds, causes and effects of weld spitting and indentation, machine set up, and care of electrodes. I believe that you will find that most of the operators are interested in learning more about their machine and will read the booklet diligently.

The ideal system for setting up the machine would be to have a technically trained set-up man responsible for the quality of welds turned out on his machines. The number of machines under his control would depend upon the number of machines in the shop and the floor layout. With this system, the operator is responsible only for placing the spot welds. The set-up man should be equipped with instrumentation for checking the variables time, pressure and current and, in this way, he could set them more precisely. A typical set-up bench might include water pressure, flow and temperature checking apparatus shown on the upper left panel in Fig. 2, and current measuring apparatus laid out, Fig. 3. Inspection of the welds should be carried out at the machine. As a check on the machine setup, a number of routine tests could be run periodically, such as tensile tests, cross sectioning the weld and etching, x-ray, etc., depending on

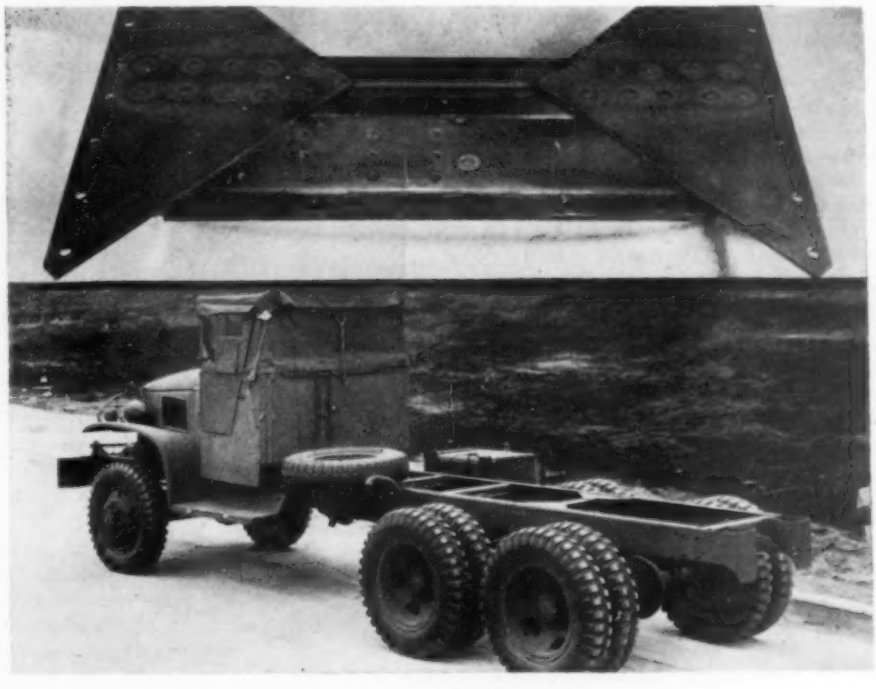

Fig. 1—6 x 6 Military Vehicle

* Presented before Cleveland Section of A.W.S., March 10, 1948.

† Welding Engineer, GMC Truck & Coach Div., Pontiac, Mich.

Fig. 2 (Left)—Set-Up Bench

the facilities available. If carried through properly from the beginning, there should be no necessity for rejection of the final products due to faulty welds.

We should give more consideration to the care of electrodes and holders by providing adequate water cooling and a good system for maintaining the proper contact face area. The system for dressing electrodes that I believe merits consideration is to use ejector-type holders where possible, replacing the electrodes when they need dressing. A supply of dressed electrodes should be made available at the machine and the used electrodes collected at the end of the shift. They could be dressed in a lathe with special tools in approximately $^1/_2$ sec. apiece. This system would make it possible to prolong the life of electrodes, shorten machine down time for dressing electrodes and give a better welding condition than was possible with the use of files, wire cutters and chisels in common practice for removing mushrooming.

Maintenance of equipment has a profound effect upon the quality of spot welds. I would like to promote the idea of having a separate spot welder maintenance department whose function is to handle any machine problem up to the power source. The maintenance man should be trained to handle all minor electrical and mechanical problems involved with a spot welder. He should carry out a preventive maintenance program, making checks on certain parts of the machine hourly, daily, weekly, monthly and annually. He should not be charged with the care of more machines than he can efficiently handle. R.W.M.A. publishes a bulletin on maintenance of spot-welding machines, including a preventative maintenance system. This bulletin would give a good start for such a program.

The system that I have given in this paper appears to be time consuming and costly. However, if you will consider the situation that many of us have today of repairing rejected parts due to faulty spot welding, performing costly metal finishing operations and replacing failed parts in the field you will find that we have a large amount of time and money to work with.

I do not wish to discourage the use of spot welding in production. If properly handled, it can be a very dependable low-cost, high-speed method of fabrication. Spot welds can be made in many cases at a cost as low as 2 or 3 mils apiece while riveting and other joining processes cost considerably more to apply.

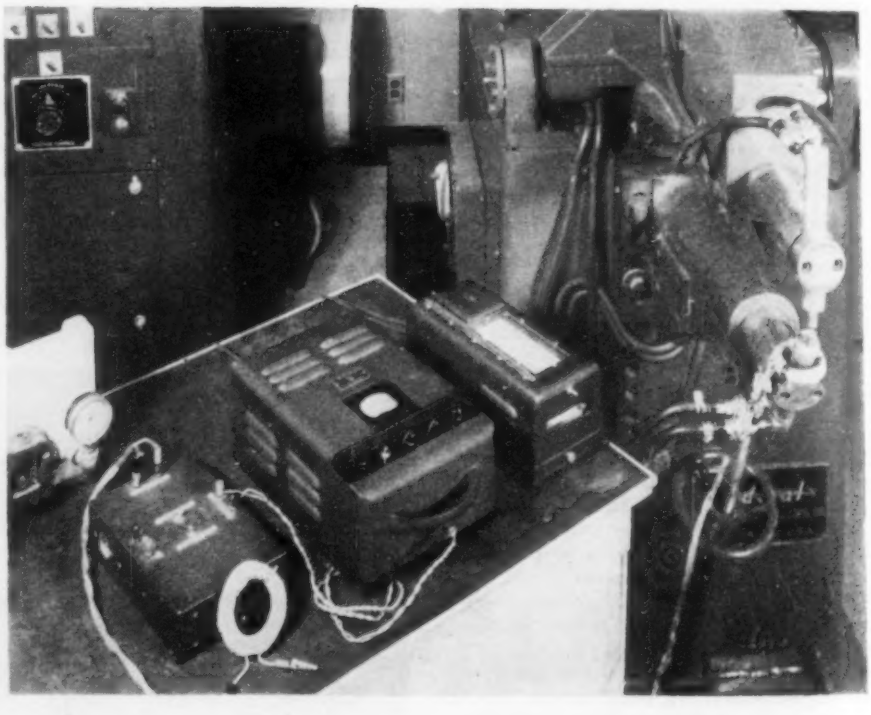

Fig. 3 (Right)—Current Measuring Apparatus

Contact Electrodes and Applications of Contact Arc Welding

By P. C. van der Willigen and G. Zoethout*

Translated and Edited by A. B. Tesmen†

The special characteristics of Contact Arc Welding are shown as applied to vertical and horizontal welding. Advantages are set forth and a new application "contact arc spot welding" is discussed.

Introduction

IN THE May 1946 Research Supplement of THE WELDING JOURNAL one of the authors[1] described a new method of welding called Contact Arc Welding, which is a combination of touch welding, automatic starting and reigniting of the arc. This new method was the outcome of an investigation carried out with several objectives in view, one of them of making touch welding easier and of more universal application. Until recently, touch welding was of such minor importance that the latest edition of the *Welding Handbook* (1942) does not mention it; in fact, electrode users are often warned against touching the cup of the electrode against the plate during welding.

It is known that relatively heavily coated electrodes are required for touch welding, and the obvious method is that of increasing the amount of slag-forming materials in the coating. However, this results in the lowering of the iron to slag ratio which is more or less a constant factor for a given type of electrode. Moreover, the greater quantity of slag (the result of a heavier and hence a more expensive coating) causes welding difficulties, as more heat is required for melting this extra amount of slag.

The Contact Electrode coating is made thicker by incorporating a large amount of iron powder with the flux ingredients; thus the iron-to-slag ratio is not changed and the ratio, iron in the coating/total iron content, can be adjusted to give the best touch welding properties in various welding positions. This results in advantages not possessed by ordinary touch welding electrodes; for example, the deposition rate of Contact Electrode C-20 is higher with the same current when compared with the standard electrodes of the same coating type. The same does not hold true for touch welding electrodes made by decreasing the iron-slag ratio. Another factor allowing the greater speed of welding with Contact Electrodes is the result of the special shape of penetration (shown in Figs. 12 and 13 of reference 1), deep in the center and shallow on the sides, permitting the use of heavier electrodes and greater currents without the danger of undercut.

The self-starting feature of Contact Electrodes permits a new welding application, Contact Arc Spot Welding which will be described below.

The self-starting is due to the large amount of powdered iron in the coating which renders the coating conductive. The small auxiliary current which flows through the coating when the contact is made between the plate and the coating is sufficient to start the arc. Another important feature facilitating the spot welding and other applications of Contact Electrodes is the deep and strong cup which is formed during welding; this cup prevents freezing of the electrode even if the electrode is placed perpendicularly on the plate as in the case of spot welding.

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† North American Philips Co., Dobbs Ferry, N. Y.

Pick-up of Elements from the Air

The deep cup, in contact with the plate, surrounds the arc to a much greater extent than in the case of free arc electrodes, the cup of which is shallow with an open space between the cup and the plate, allowing a greater amount of nitrogen and oxygen to approach the arc atmosphere.

We have found the nitrogen content of the deposited weld metal of all types of Contact Electrodes to be one third of corresponding values of free arc electrodes. The nitrogen analyses of the latter range from 0.01 to 0.04%, depending on the type of coating, and the nitrogen percentages of the corresponding Contact Electrodes, are 0.002 to 0.008%. The nitrogen range of Bessemer steel is about the same as that of standard free arc electrodes, while the nitrogen range of open hearth steel corresponds to that of the Contact Electrodes.

The oxygen content of Contact Electrode weld metal did not show appreciable differences when compared with standard electrodes. This is due to the fact that the oxygen content of deposited metal is mainly determined by the oxidizing and reducing ingredients of the coating.

There has been a difference of opinion regarding the relative influence of nitrogen and oxygen on the mechanical properties of steel; the difficulty is that steel always contains both elements at the same time. This is also true for the deposited weld metal, where this situation is further complicated by the state in which both elements are present in the metal. The question can be answered only by investigating the separate influences of nitrogen and oxygen in very pure iron. During the last few years extensive research work in our Physical Laboratory was carried out by J. D. Fast, who used a special high-frequency furnace in which the iron was purified by melting it in argon; the result of this research, which will be published,[2] shows that nitrogen causes strain-aging in iron, whereas oxygen does not. This conclusion is in accordance with the present theory of strain-aging (which postulates that strain-aging is due to elements which are in super-saturated solution) because nitrogen shows some solubility which decreases very much at lower temperatures, and oxygen does not show any solubility in solid iron.

The Different Types of Contact Electrodes

In the first article,[1] the special features of the Contact 15 (abbreviated as C-15) electrodes were described. This

electrode was derived from the low hydrogen electrode Ph-55, which is of the E7015 classification.

Contact 18 (C-18) electrode is derived from the standard free-arc electrode Ph-48 of E6012–13 classification. Contact 20 (C-20) electrode is based on standard free-arc electrode Ph-50 of E6020–30 classification. Table 1 summarizes the various types.

Table 1

Contact Electrode	Derived from the Standard Free-Arc Electrode
C-15	Ph-55 (A.W.S. E6015–7015)
C-18	Ph-48 (A.W.S. E6012–13)
C-20	Ph-50 (A.W.S. E6020–30)

Contact 18 (C-18) Electrodes

This electrode has a lighter coating than the other two types, with a smaller amount of slag which is easier to control in difficult welding positions. Contact 18 electrodes are particularly illustrative of one of the principal advantages of contact welding; namely, of rendering the variable welding factors of arc length, electrode angle and the speed of travel more constant. This eliminates the defect of arc freezing and such difficulties as maintaining the proper arc length, electrode angle and arc speed.

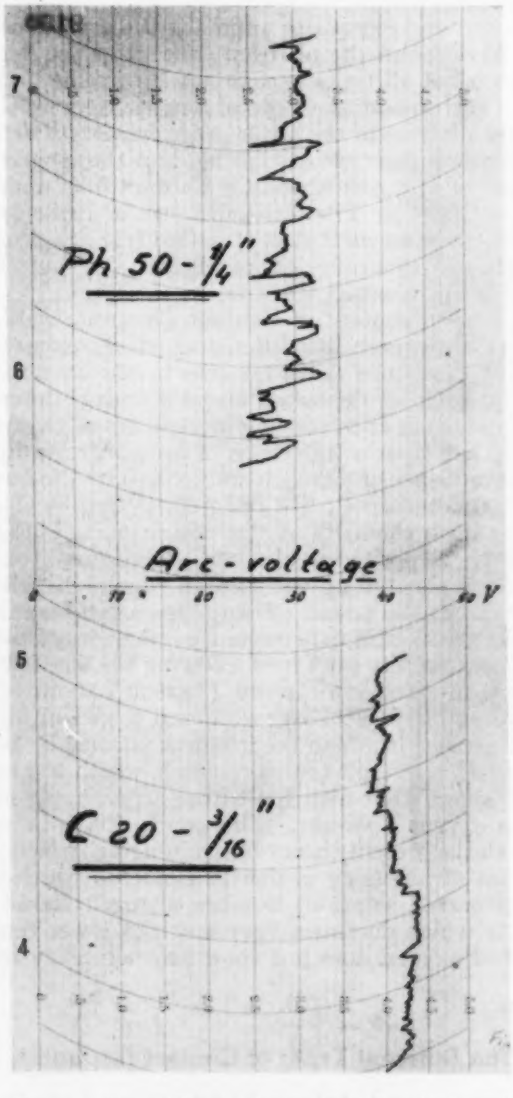


Fig. 1—Arc Voltage Curves for Standard and Contact Electrodes.

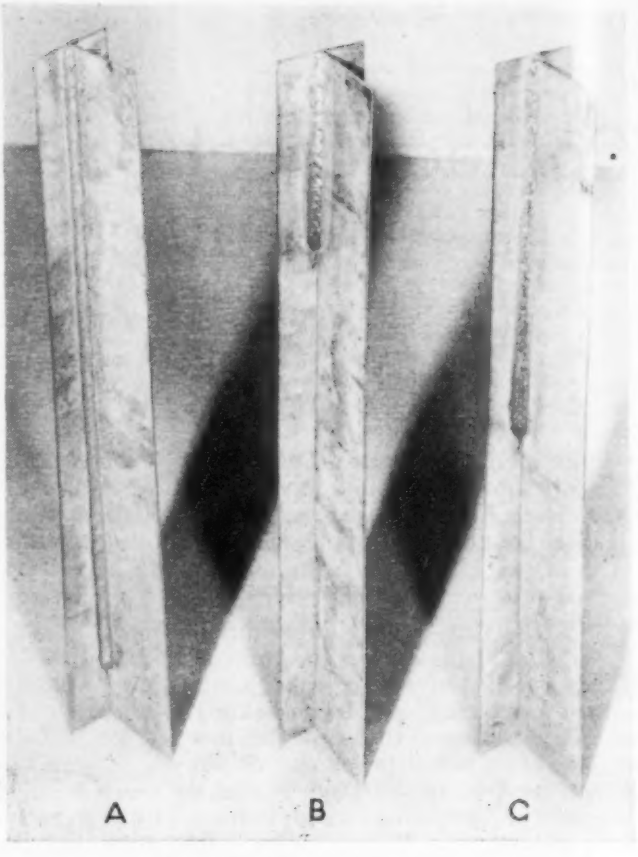


Fig. 2—Vertical Fillet Welds in Plates 2 Mm. Thick. A.—Contact Electrode Deposits, B and C—Standard Electrodes

Contact Electrode arc length is determined by the depth of the cup at the tip of the electrode and to a lesser extent by the angle between the electrode and the workpiece. Thus the current and the voltage are far less subject to the irregularities in the motion of the welder's arm. The constancy of Contact arc voltages is shown on charts of self-recording meters.

Figure 1 shows curves of arc voltages of C-20—$^{3}/_{16}$ in. and of its parent Ph-50 electrode welded in the usual manner by an experienced welder.

The net result of constant travel speed and constant arc length is uniform penetration. Chipping of the back of the root bead in butt welds and subsequent deposition of a sealing bead is a frequent procedure using standard type electrodes; in Contact arc welding deep and uniform penetration often makes this unnecessary. The deep and uniform penetration obtained by Contact Electrodes renders them particularly suitable for welding of irregular root openings and bridging varying gaps.

The following examples of two difficult positions of welding illustrate some of the advantageous applications of special features of Contact 18 electrodes.

Vertical Down Welding with C-18

Vertical down welding using standard organic electrodes is often prohibited or restricted to thinner plate sizes due to the inadequate depth of penetration and substandard throat thickness. The use of C-18 electrodes overcomes these defects, so that throat thicknesses up to $^{3}/_{16}$ in. in one layer can be obtained with adequate depth of penetration.

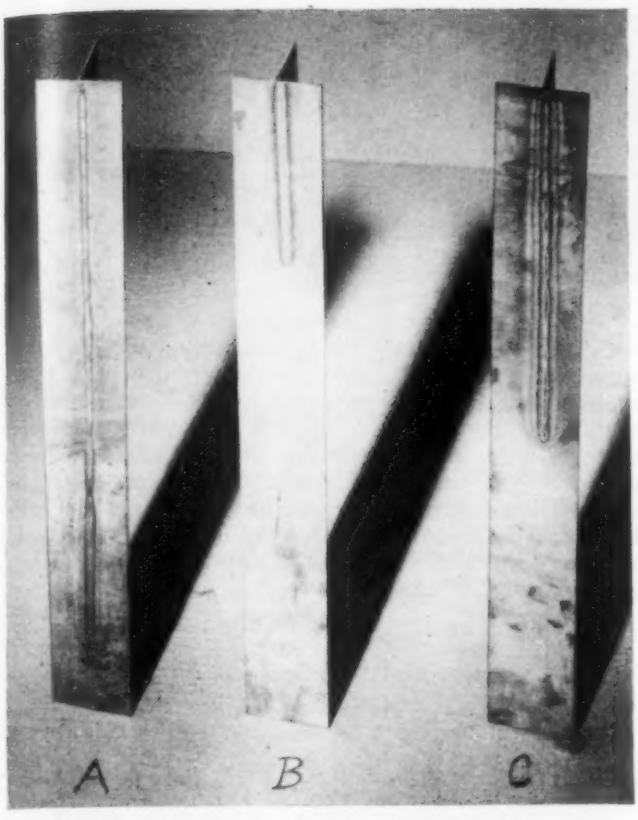


Fig. 3—Heat-Affected Zones Vertical Fillet Welds in Plates 2 mm. Thick. A—Contact Electrode Deposits, B and C—Standard Electrodes

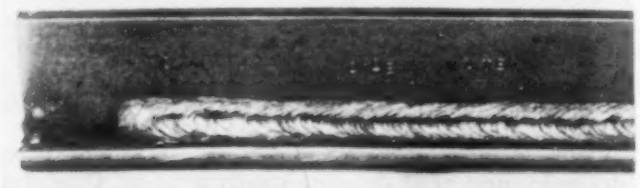


Fig. 4—Fillet Weld Made Under Water with Contact Electrodes

The deep and strong cup at the tip of the C-18 electrode forms a funnel for a relatively large amount of escaping gases. The gas stream is highly concentrated and is additive to the forces acting on the metal droplets.[3] This results in the special shape of penetration—deep in the middle, with the accompanying depth of penetration, and shallow on the sides, eliminating the chances of undercut. It is known that undercutting is one of the defects often encountered when welding with electrodes of E6010–11 classification.

Fig. 5—Cross Section of Weld in Fig. 4

Reference 4 states that, "when the arc is moved slowly, there is a pool of molten metal under the arc and the force of the arc is expended in the molten pool instead of penetrating into the parent metal at the root of the joint. This molten metal merely flows along the joint under the arc and tends to solidify in the root of the weld without fusing to the parent metal. When the arc is moved forward rapidly enough, the arc-force digs into the base metal and the result is good root penetration."

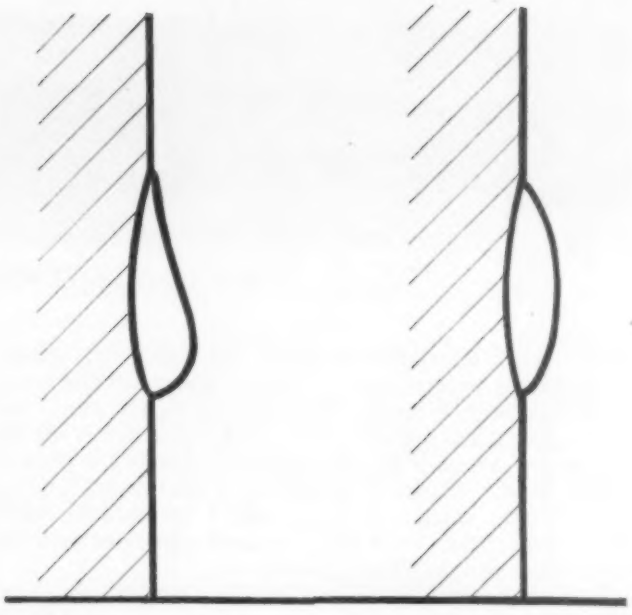


Fig. 6—Horizontal Weld with Standard Electrode

Fig. 7—Horizontal Weld with Contact Electrode

The same reasoning can be applied to vertical down welding, with the essential difference consisting of the strong tendency of the molten metal to flow down due to the force of gravity and to cover the solid metal on which the arc must burn. This tendency must be overcome by the gas stream directed toward the root of the weld and subsequently deflected in the vertical up direction against the molten pool. The combination of these forces generally results in shallower penetration than that usually obtained in down hand welding. The deep cup formed at the tip of the Contact Electrode supports this molten pool to a greater extent than a standard electrode with a shallower cup.

The result of these factors favors the application of Contact Electrodes in the vertical down position using larger diameter electrodes and higher currents than it has been possible to use until now. For example, $^{3}/_{16}$-in. rods of the C-18 type can be welded with 260 amp. This size corresponds to the standard $^{7}/_{32}$-in. electrode. A similar weld would usually be deposited vertically up

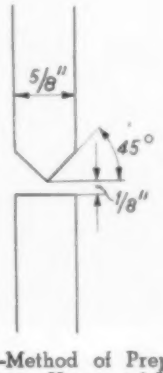


Fig. 8—Method of Preparation for Contact Horizontal Welding

Fig. 9—Bead Deposited on Both Sides of Joint Shown in Fig. 4

Fig. 10—X-ray of Weld of Joint in Figs. 8 and 9

using $^5/_{32}$-in. electrodes and about 140 amp., with considerably longer welding time. Greater linear welding speed results in less dissipation of heat into the parent metal and consequently less deformation. This difference is readily seen in the extent of the heat-affected zone in the back of a fillet weld. Figure 2 shows three fillet welds joining plates 2 mm. thick. *A* was Contact Arc welded vertically down with C-18, *B* and *C* in similar manner with the standard electrode Ph-48 (E6012–13).

Table 2 gives the currents used, bead lengths per 14-in. electrode and the widths of the inner and outer heat-affected zones which can be seen in Fig. 3.

Table 2

Weld	*A*	*B*	*C*
Electrode, in.	C-18—$^1/_8$	Ph48—$^5/_{32}$	Ph48—$^1/_8$
Current, amp.	150	75	130
Run Length, mm.	550	160	300
Width of the inner heat-affected zone, mm.	6	9	11
Width of the outer heat-affected zone, mm.	12	19	20

The extent of deformation of a water-cooled plate is still less because of faster heat dissipation. The particular ability of C-18 to weld under water was utilized in an interesting Belgian application of a welded machine part with no deformation allowance. The workpiece was placed under water and the C-18 electrodes were used for the job because of their ability to weld under water with good results. Figure 4 shows a fillet weld made in the flat position under water, using C-18—$^5/_{32}$ in., 190 amp., DC-Straight Polarity. Figure 5 shows a section of the same weld: the root penetration is very deep, due to the high arc tension under water, 44 v. The maximum weld metal hardness is 200 Vickers when mild steel parent metal is used, notwithstanding the extreme cooling conditions. The welds are free of cracks; the deposited metal has a dendritic structure and does not show blowholes or slag inclusions. Vertical down welding under water produces similarly satisfactory results and welds of good external appearance.

Horizontal-Vertical Welding

Special qualities of C-18 also adapt it to this type of application, easily demonstrated by depositing a horizontal bead on a vertical plate. Standard electrodes usually deposit a weld of sagging contour, as shown in Fig. 6, whereas the C-18 electrodes produce a symmetrically shaped bead as in Fig. 7. This is a result of the supporting effect of the deep cup and of the concentrated blowing action against the molten pool. Consequently, electrodes of heavier diameters can be used for groove welds. These factors combined with good penetration characteristics of C-18, make it possible to use smaller joint angles, such as 45° for single- and double-bevel butt welds in horizontal-vertical position.

Figure 8 shows the example of a $^5/_8$-in. double-bevel butt weld, first bead deposited with a $^3/_{16}$-in. C-18 electrode. This single bead was deposited on both sides of the bevel joint in a manner which creates an impression of two layers, one on each side, as seen in Fig. 9. The

Fig. 11—Low-Pressure Storage Tanks Fabricated with Contact Technique.

Fig. 12—Welding in Ship Construction

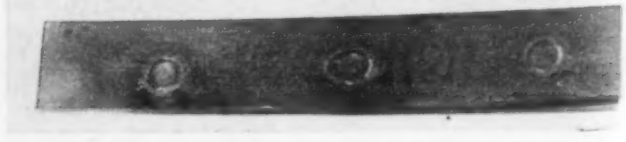


Fig. 13—Contact Arc Spot Welds

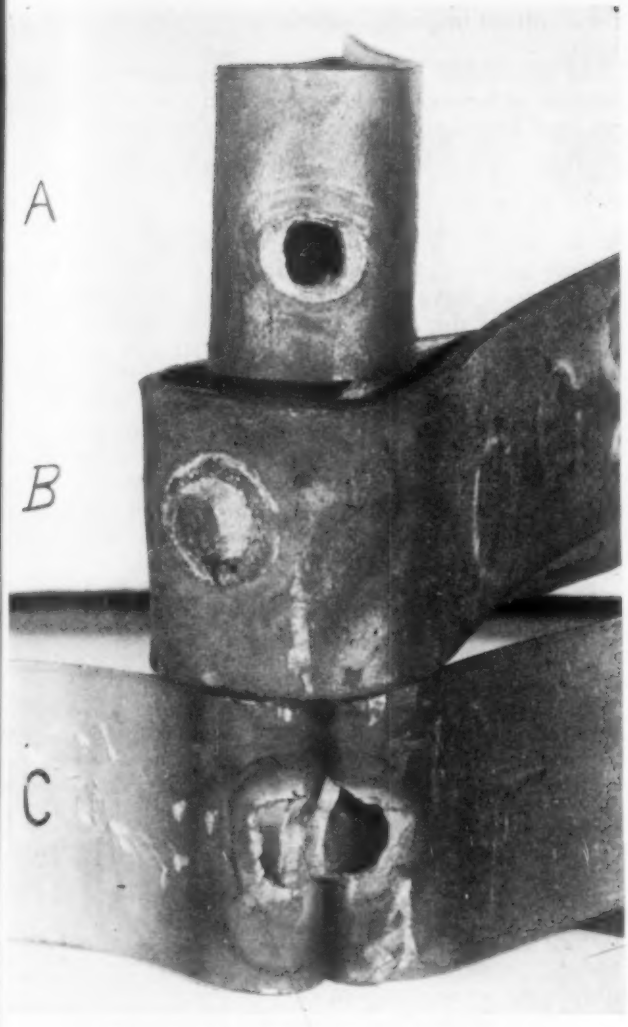


Fig. 14—Test of Welds Shown in Fig. 13

bead appearance on both sides is very smooth and the subsequent layers can be deposited without the preliminary chipping of the bottom side of the weld. This remarkable feature obviously results in great economic advantages. The soundness of the weld can be seen in Fig. 10, an x-ray photograph of such a joint.

Figure 11 shows low-pressure storage tanks which were welded using the Contact technique in vertical down and horizontal in vertical plane positions with C-18 electrodes. No chipping was necessary on this job.

The welding of part of a ship is illustrated in Fig 12. This weld was deposited in the inclined position and partly in the flat position using C-18 electrodes throughout.

Contact Arc Spot Welding

Because Contact Electrodes do not freeze on touching the workpiece, they can be used for "contact arc spot welding." Sheet metal from $^1/_2$ mm. ($^1/_{32}$ in.) to 3 mm. ($^1/_8$ in.) in thickness has been welded with excellent results. It is possible to weld a thin upper sheet to a thick bottom sheet, for instance, a 1-mm. (20-gage) sheet to a 12-mm. ($^1/_2$-in.) plate without difficulty.

A good contact between the plates to be spot welded is, of course, essential. The electrode is placed perpendicularly on the top sheet. The arc starts and then the electrode is lightly pushed through the top plate into the bottom plate. The tip of the electrode passes through the molten spot in the upper sheet and comes in contact with the bottom plate. As soon as the interfaces are in a molten state, the electrode is withdrawn and the void is filled up with a light quick motion. The entire procedure takes one or two seconds. The technique is rather simple, but its rapidity requires some experience to insure the best results.

Figure 13 shows the appearance of a Contact arc spot-welded testpiece.

Figure 14 shows two other spot welds after deformation tests. It is seen that the welds were completely torn out of the parent metal (*A* and *B* are the parts of one of the spot-welded testpieces, and *C* shows a spot weld torn out of both parent strips).

Contact 20 (C-20) Electrodes

The Contact-20 electrodes have been derived from the Ph-50 type (E6020–30 class) and are designed for horizontal and flat positions of welding.

The higher deposition rate of C-20 when compared with Ph-50 is shown in Fig. 15.

It is known in electrode design that the slag-iron ratio is somewhat increased with the increase in the electrode diameter. However, the C-20 and Ph-50 electrodes used in the illustration, Fig. 15, all have the same slag-iron ratio. The principal difference between the coatings of C-20 and Ph-50 electrodes is that the former contain a large amount of iron powder, which results in 30% higher deposition rates using welding currents of the same magnitude. Moreover, the very heavy heat-resistant coatings of Contact Electrodes can carry higher currents than the coatings of standard electrodes of the same core diameter. For example, C-20—$^3/_{16}$ in. has a maximum current capacity of 320 amp., whereas the current capacity of Ph-50—$^3/_{16}$ in. (E6020–30) is only 255 amp. Figure 15 also shows that the deposition rate of C-20 $^3/_{16}$ in. at its maximum current capacity is 75% higher than the corresponding figure for the standard Ph-50 electrode of the same core diameter operating at its maximum current capacity.

The special form of penetration, deep in the middle and

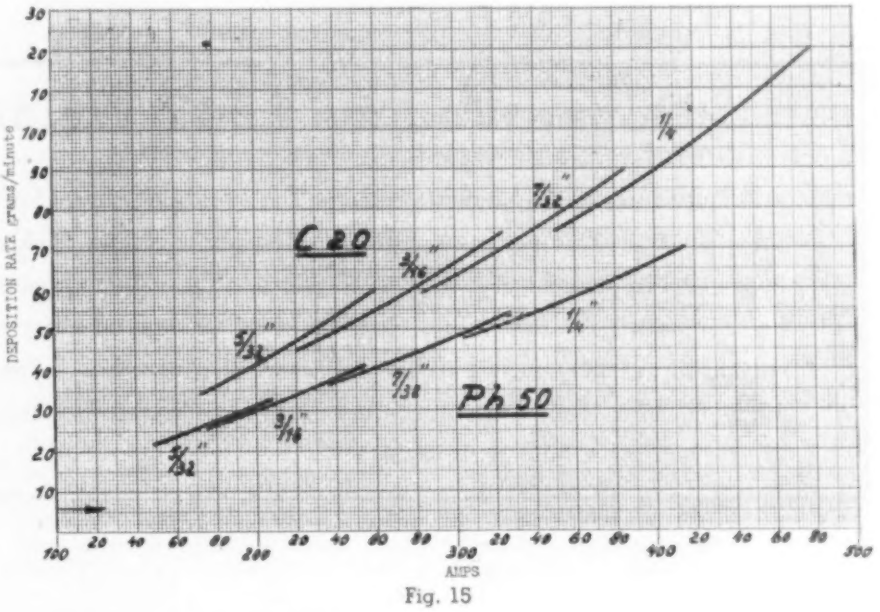
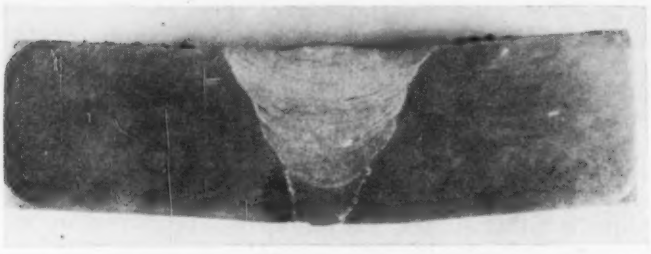


Fig. 15

Fig. 16—Weld with Standard Electrode



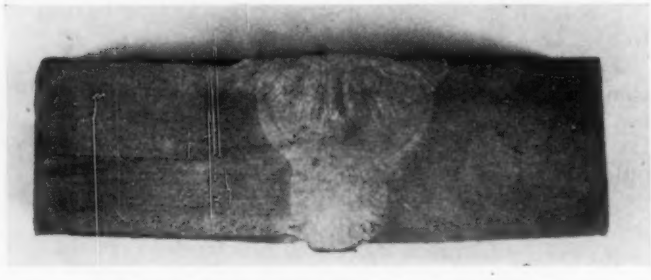


Fig. 17—Weld Made with Contact Technique

shallow on the sides, makes it possible to use Contact Electrodes of one size larger core diameter than of the nominally used standard electrode. The above-described three advantages combine to produce considerable savings in welding time, especially in heavy downhand butt welds.

The comparison of Figs. 16 and 17 demonstrates the difference in the two welding techniques. Figure 16 shows a normally bevelled Vee-butt in a $^5/_8$-in. plate; the groove was filled in 5 layers with standard free-arc electrodes. The included bevel angle was 70°. Figure 17 shows the cross section of a Contact arc weld in plate of the same thickness. The included angle was only 50° and the groove was filled with Contact rods in three layers.

The combination of heavy electrodes, high current and high arc voltage increase the heat input per layer, with the resultant improved mechanical properties of the weld joint.[5]

As distortion is approximately proportional to the number of layers, it is lessened when Contact Electrodes are used instead of standard free arc electrodes.

Summary

This paper describes Contact Electrodes C-18 and C-20, which have been derived from standard free arc electrodes of the E6012–13 and E6020–30 classification, respectively. The special characteristics of Contact arc welding, described in a previous paper in this JOURNAL[1] are now demonstrated in applications of vertical down and horizontal-vertical welding with C-18, and groove welding with C-20. The special welding technique, resulting in greater speed of welding, is discussed, and the principles on which this technique is based are outlined. A new welding method called contact arc spot welding is also discussed.

Acknowledgments

The authors wish to express their appreciation for the contributions made by Ir. W. P. van den Blink, Physical Laboratory (Eindhoven), W. Moerman, Welding Department (Utrecht), and A. B. Tesmen, North American Philips Company (Dobbs Ferry, N. Y.)

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2. Fast, J. D., *Philips Technical Review*, **10** 26 (1948); more details in one of the next Philips Research Reports.
3. Sack, J., *Ibid.*, **4** 9 (1939); see also Fast, J. D., *loc. cit.*
4. *Procedure Handbook of Arc Welding Design and Practice*, Eighth edition, The Lincoln Electric Co., Cleveland, Ohio, p. 180 (1945).
5. *Guide to Weldability of Steels*, published by the AMERICAN WELDING SOCIETY, New York City.

Bound Volume 1947 Welding Journal

A few copies of the bound volume of The Welding Journal for the year 1947 are still available. Price $12.50. This volume consists of 1164 pages of The Welding Journal and 752 pages of the Research Supplement, a total of 1916 pages. The volume contains a Subject and Authors Index and represents a veritable encyclopedia of information on every phase of welding. The research section represents nearly a million dollars worth of research. The Journals are bound in attractive imitation black leather covers. Orders may be placed with the American Welding Society, 33 West 39th Street, New York 18, N. Y.

SOCIETY NEWS

LECTURE SERIES A NEW FEATURE OF A.W.S. ANNUAL MEETING

The first Educational Lecture Series at the Annual Meeting in Philadelphia will give members and guests of A.W.S. an opportunity to learn more about "The Metallurgy of Arc Welds in Steel." Presented by Dr. R. D. Stout, Department of Metallurgy, Lehigh University, the lectures will be given on Monday, Tuesday Wednesday, October 25th, 26th and 27th, from 4:30 to 6:00 p.m. at the Commercial Museum and Convention Halls.

The lecture series, sponsored by the Educational Committee of the Society, will be an open meeting, a new feature of the Meeting to which all members and guests are cordially welcomed.

ANTHONY WAYNE SECTION BEING ORGANIZED

A formal request for the establishment of the Anthony Wayne Section (Fort Wayne, Indiana) of the AMERICAN WELDING SOCIETY has been received at Society Headquarters and has been acted upon favorably by the Board of Directors. This new Section already has 27 Members and undoubtedly there will be some transfers from other localities which can be best served by this Section. The following officers have been selected:

Chairman, George H. Laws, Shop Supt., Ruckman & Hansen, Inc.; *1st Vice-Chairman*, Harold Hamilton, Plant Equipment and Design Engineer, International Harvester Co.; *2nd Vice-Chairman*, Glen D. Birt, Vice-President in Charge of Production and Manufacturing, American Steel Dredge Co.; *Secretary-Treasurer*, Harry M. Johnson, Sales Manager & Partner, Wayne Welding Supply Co., Inc.

Board of Directors: Russel F. McNutt, Manager, Sutton-Garten Co.; G. H. Russell, Vocational Director Public Schools, Central High School; Arthur E. Bowers, Supt., C. L. Schust Co., Inc.; L. J. Klingenberger, Chief Methods Engr., Wayne Pump Co.; I. A. Rollins, Supt. McCray Refrigerator Co.; Lorin A. Snyder, Vice-President in Charge of Production, Bowser, Inc.; Stewart Morgan, Welding Foreman, Wayne Pump Co.; Fred C. Wilt, Asst. Supt., American Steel Dredge Co., Inc.; George A. Leaming, Division Supt., Bowser, Inc.; John Shier, Welding Supt., Wermuth, Inc.; Robert C. McCoy, Prop., McCoy's Welding Works.

MEETING OF BOARD OF DIRECTORS, AMERICAN WELDING SOCIETY

A meeting of the Board of Directors of the SOCIETY was held in The Bellevue-Stratford, Philadelphia, Pa., Monday, May 17, 1948.

Members: H. O. Hill, C. A. Adams, D. H. Corey, R. S. Donald, O. B. J. Fraser, W. F. Hess, G. O. Hoglund, T. M. Jackson, C. H. Jennings, C. I. MacGuffie, L. S. McPhee, J. F. Maine, H. W. Pierce, G. N. Sieger, R. D. Thomas, J. B. Tinnon, G. M. Trefts III and A. C. Weigel.

By Invitation: E. V. David, Chairman, Convention Committee; G. E. Doan, Chairman, Awards Committee; R. M. Gooderham, Manager, Canadian Welding Bureau and R. A. Guenzel, Secretary, Philadelphia Section.

Attending Afternoon Session: S. J. Oechsle, Member, Philadelphia Section.

Staff: J. G. Magrath, *Executive Secretary;* W. Spraragen, *Editor*, THE WELDING JOURNAL and M. M. Kelly, *Secretary.*

Report of Executive Secretary on Section Activity, Findings and Recommendations

The order of business, as shown on the agenda, was changed in order to give this report first place.

Report, dated May 17, 1948—distributed at the meeting and since circulated among the members not present—was highlighted by the Executive Secretary. He "briefed" orally the various sections of the report, concentrating on Section 2 (expansion), Section 3 (Membership), Section 5 (JOURNAL), Section 6 (*Handbook*) and Section 8 (Exposition).

Mr. Magrath contended that inasmuch as the report contains the findings and expressed opinions of over 500 Section Officers in 50 Sections throughout the country, in addition to the opinions of some National Officers and of individual persons, expressed orally during his visits to the Sections, it truly represents the thinking of the SOCIETY as a whole and, therefore, in shaping the pattern of SOCIETY activities for the future, cognizance ought to be taken of the desires of the membership, as indicated in the report.

He believes our membership loss, to a certain extent, has been the natural result of a war-inflated membership. But he contends that, to an increasing extent, the more recent membership loss has been due to dissatisfaction with our SOCIETY's activities. He observed that on an official report of the "Breakdown of Members Dropped 3/31/48," the following is shown on a percentage basis of 735 dropped members:

(*a*) Of 735 dropped members, 62% are in "C" classification; 37% are in "B" classification; and nearly 1% are in "A" classification;

(*b*) Of 735 dropped members, we note the following:

16.8% are of Executive occupations
17.5% are of Engineer occupations
7.6% are of Welding Engineer occupations
20.4% are of Welding Supervisor occupations
22.0% are of Welding Operator occupations
4.5% are of Sales occupations
11.2% are of Miscellaneous occupations

(*c*) If we compare "Welding Operator" with "Others," we have:

22.0% loss in "Welding Operator" occupations
78.0% loss in "Others" occupations

(*d*) If we compare "Production Group" (welding operators and supervisors) loss with "Others," we have:

42.4% loss in "Production Group" occupations
57.6% loss in "Others" occupations

He pointed out the great need for fundamental welding data for the designer, draftsman, production groups and manual arts levels. The potentialities here are enormous and the SOCIETY's activities should, therefore, be supplemented with added activities to meet the great demand among these groups for practical information in all the SOCIETY's activities, including publications. It is recommended that

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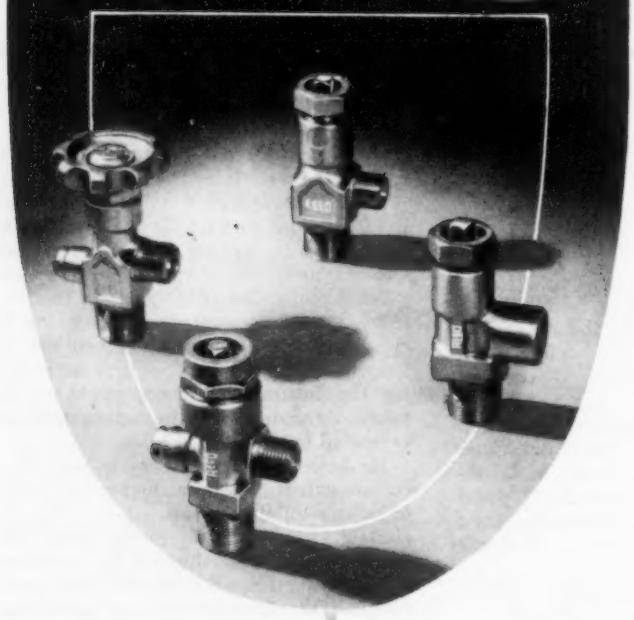

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the Publication, Handbook and Educational Committees take this matter under advisement. The Handbook Editor is making every effort to accelerate progress in the completion of the third edition of the *Welding Handbook*.

Mr. Magrath reported on the planning for membership drives to commence in the early fall; for the formation of the Sections, sub-Sections; and for the reactivation of some of the present Sections.

Mr. Magrath was commended for the excellent summary and presentation of the findings and expressed opinions of the 50 Sections he visited.

The report of the Executive Secretary on Section Activity, Findings and Recommendations, submitted to the Board of Directors on May 17, 1948, was accepted with thanks. Acting on the recommendation of the Executive Secretary for distribution of the report, the Board voted that this report in its entirety, or in part, whichever is deemed advisable by the President, be circulated by the Secretary of the SOCIETY, to the interested Standing and Special Committees, with request that these Committees review same and submit comments thereon to the Board of Directors for study, sufficiently in advance of the next Board meeting, in order that prompt action may be taken on recommendations contained in the report and the Executive Secretary's promotional activities may proceed as quickly as possible along the paths decided upon by the Board of Directors.

On further recommendation of the Executive Secretary, the President was empowered to appoint a Committee, with scope to study remarks on By-Law amendment ballots returned by A.W.S. membership, for the purpose of acquainting the Board, at its next meeting, with the trend of thought of the membership in respect to proposed changes in By-Laws, recently submitted to them.

Mr. Hill named Messrs. Sieger, Fraser, Pierce, Donald, Magrath, Hill and Miss Kelly, members of this Special Committee.

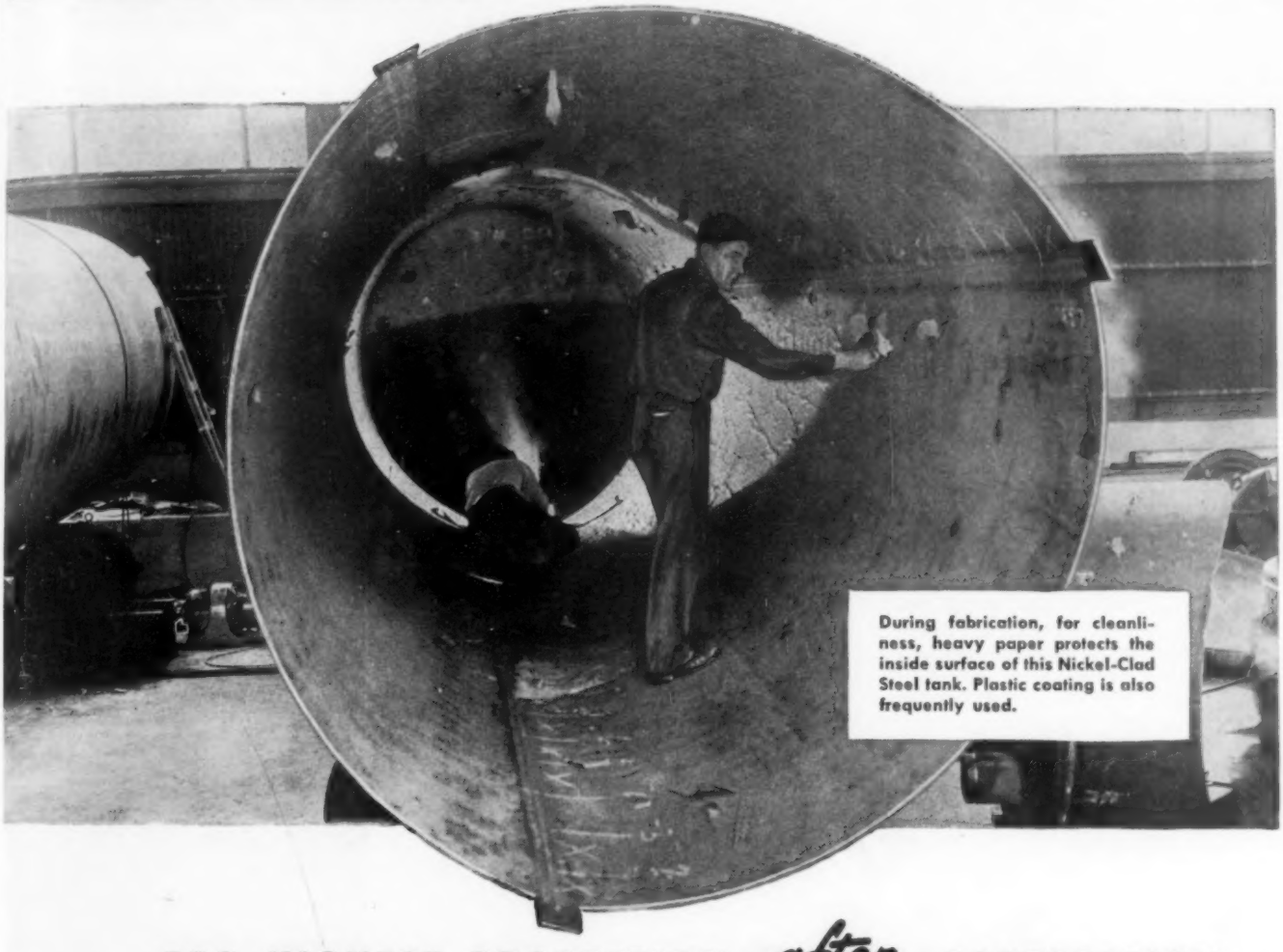
A.W.S. Participation in International Institute of Welding

Memorandum, summarizing events leading to the designation of R. D. Thomas as A.W.S. representative at the inaugural meeting of the I.I.W. in Brussels, June 8–11, 1948, was distributed at this meeting. Mr. Hill reported that Mr. Thomas has been asked to represent the Canadian Welding Bureau also at the Brussels meeting. At Mr. Hill's direction Mr. Thomas invited Mr. Gooderham, Manager of the Canadian Welding Bureau, to the Board meeting to listen to discussion on this subject.

At the request of Mr. Thomas for instructions as A.W.S. representative at the Brussels meeting, the Board, after deliberation, adopted the following Resolutions:

RESOLVED, That the Board of Directors of the AMERICAN WELDING SOCIETY in session in Philadelphia on Monday, May 17, 1948, looks favorably upon international cooperation in welding standardization, research and the ex-

PROTECT ALL CORROSION-RESISTANT MATERIALS *during* FABRICATION



During fabrication, for cleanliness, heavy paper protects the inside surface of this Nickel-Clad Steel tank. Plastic coating is also frequently used.

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Nickel, stainless steel, Inconel and Monel, permanently bonded to steel backing plates, provide the protection offered by these *solid* corrosion-resistant metals at the lower cost of *clad* steels. Lukens Clad Steels owe their superior performance in service to care in their manufacture as well as in their fabrication.

When Lukens Clad Steel plates are shipped from the mill, there are no inclusions in their surfaces to become focal points for corrosion. Sodium hydride finish assures no roughness or pitting to make cleaning difficult. And, as with all corrosion-resistant materials, the fabricator should avoid contamination of the surface with shop dirt by applying a protective paper or plastic coating to the cladding.

Plates should be handled around the shop with the clad side *up* to prevent gouging and deep scratching. Bending rolls, dies and tools should be kept free of scale and steel particles which might become imbedded in the clad surface.

Lukens new 100-page booklet, "Fabrication of Lukens Clad Steels", contains information that should be helpful to you. For a copy of this Bulletin 399, write Lukens Steel Company, 407 Lukens Building, Coatesville, Pennsylvania.

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change of information, and to that end, R. D. Thomas, a Director of A.W.S., was authorized to represent the A.W.S. at the Organization Meeting of the International Welding Institute in Brussels, Belgium, June 8–11, 1948. If, in the opinion of Mr. Thomas, these objectives can be attained by the proposed Organization, Mr. Thomas is authorized to commit the AMERICAN WELDING SOCIETY to membership in the International Institute of Welding for a period of one year at a nominal cost.

The meeting adjourned for luncheon at 1 P.M., and reconvened at 2 P.M.

Finances

Financial report on status and results of operation of the SOCIETY for the six months' period ended March 31, 1948, was reviewed briefly by the Treasurer. He drew attention particularly to the following:

Despite savings effected in the various departments, notably, JOURNAL, Section Activities and Administration, the operations these past six months have resulted in an expense over income of $6938.56, as against an excess income over expense of $1205.56 during the same period the previous year. The membership dues loss is due primarily to writing off, at this time, dues arrearages of six months or more. The membership gain for the period totaled 862, loss 1070, or a net loss of 208 members, compared with 311 members for the same period a year ago.

Report on financial status and operations of the SOCIETY for the six months' period ended March 31, 1948, was accepted.

Mr. Donald stated that in accordance with request of the Board, at its meeting last March, he had obtained from the Publication Committee information to show savings that might be effected by separating and issuing separately THE WELDING JOURNAL and its Supplement. Communication from Mr. Oehler, the Chairman of the Committee, containing this information, was transmitted to the Board of Directors for study. Mr. Donald reported that after digesting the data, the Finance Committee came to the conclusion that before any revolutionary change is made in the present publication, which would involve a financial risk, questionnaire, sounding out member interest, similar to the one sent out in 1945, again be sent to the A.W.S. membership. It is the opinion of his Committee that such questionnaire would give a truer picture of the members' wishes, than reaction obtained at Section Executive Committee meetings.

Mr. Tinnon disagreed with general findings that the Supplement is an important part of THE WELDING JOURNAL. He felt space now devoted to the Supplement could be utilized to advantage for welding material of value to a great proportion of the membership.

In the ensuing discussion, the Executive Secretary stated he, personally, does not favor the separation of the JOURNAL and Supplement. He believes the JOURNAL, as is, is serving satisfactorily a large percentage of the membership. However, there is great need for additional material of value to the designing engineer and those of the manual arts level. Alternate plans for publication of all material have been offered. It is his belief, to meet the wishes of the membership and advertisers, that the JOURNAL must be "dressed up," its format changed, and many highly technical articles abstracted to have space for practical data.

The JOURNAL Editor stated that on several occasions consideration has been given the matter of JOURNAL improvement along the lines indicated and action was postponed because of the excessive cost, which would eat into the income needed for other activity programs of the SOCIETY. The Editor made the further point, that the proposed plan does not appear to provide for publication of Annual Meeting papers.

After deliberation, the Board voted to request the Publication Committee to study carefully comments contained in report of Executive Secretary, dated May 17, 1948, to consider the advisability of sending a questionnaire to the membership, to determine reader interest, and to be prepared for a full discussion on subject "The Present WELDING JOURNAL vs. Proposed Changes in the SOCIETY'S Publication," at a meeting of the Board of Directors with the Publication Committee, to be called by the President of the Society.

1948 Annual Meeting

Mr. David, Convention Committee Chairman, reported on progress that has been made to date in the Annual Meeting

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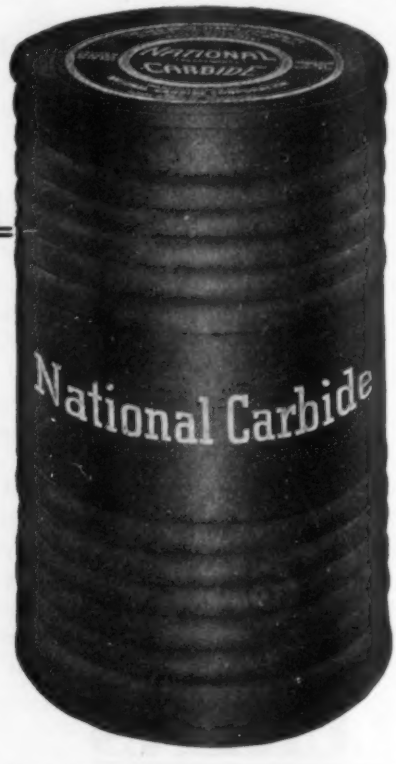

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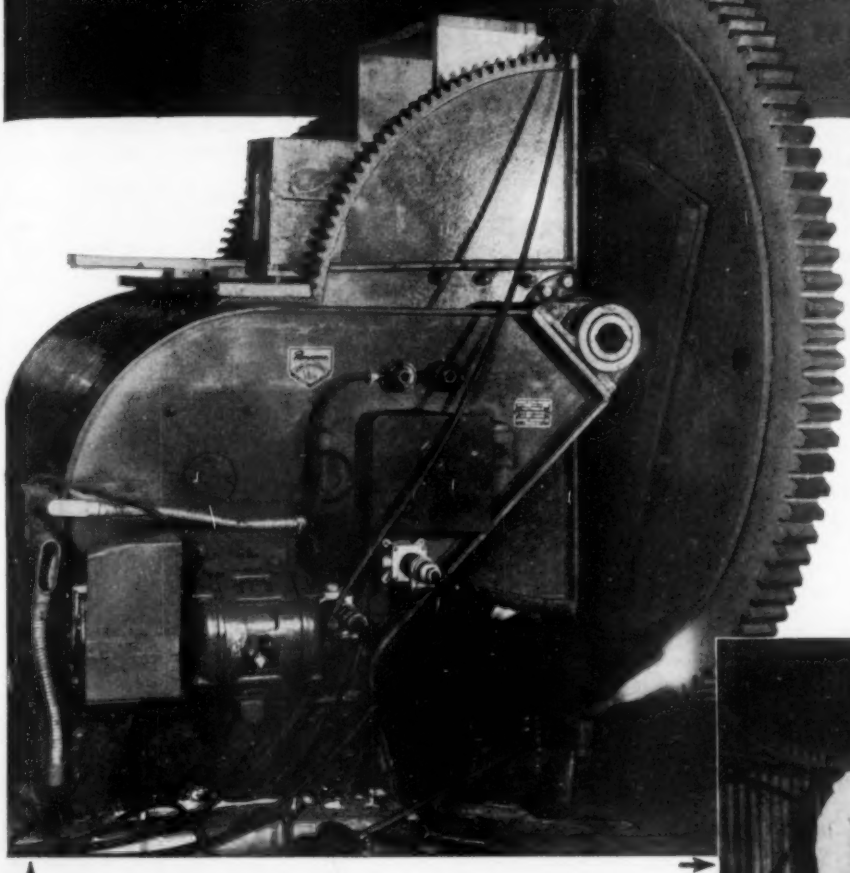

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plans. Card correcting meeting dates, as shown in previous announcement of the Meeting, was sent in a mailing to the membership in April. Our allotment of sleeping rooms in The Bellevue-Stratford (Headquarters Hotel) has been filled. Reservations are now being turned over to the Sylvania and John Bartram Hotels, in accordance with arrangement effected with the management of these Hotels. Plans are for the Chairman and the Secretary of the Convention Committee to meet with the Hotel Management and review reservations received to date.

The Convention Housing Bureau, under the sponsorship of the National Metal Congress, is being organized and will have on it two representatives of each of the participating Societies. A meeting of this group will take place in Philadelphia some time in August, and all applications for sleeping rooms will be reviewed at that time. The Philadelphia Convention Bureau has committed itself to the Congress for 4000 sleeping rooms.

Unfortunately, the Ball Room in The Bellevue-Stratford is not available for the A.W.S. Annual Dinner. The Dinner Committee is accordingly laying its plans for a dinner in the Rose Garden on the Roof of the Hotel.

The technical program is well under way and gives promise of being outstanding this year. Four meetings of the Program Committee have been held to date. In addition to the technical meetings, the events include the President's Reception on Sunday evening, Awarding of Medals and Prizes and the Adams Lecture on Monday evening, Section and Research Conferences on Wednesday evening, Plant Visitation on Thursday afternoon, the Annual Dinner on Thursday evening, and the Annual Business Meeting of the Society and Directors' meeting on Friday afternoon. A unique feature this year is the Educational Lecture Series requested by the membership, and sponsored by the Educational Committee. The lectures will be held in Convention Hall because of its nearness to an important educational center, and because of the desire to attract attention to the Exposition. The series will consist of three lectures of $1^1/_2$ hours each, held in the late after noon on the first three days of the week.

Awards

Dr. Doan, Chairman of the Awards Committee, announced his Committee's choice of J. J. Crowe as the 1947 Samuel Wylie Miller Memorial Medallist.

Further, he offered for consideration of the Board his Committee's nomination of Prof. Wilbur M. Wilson, of the University of Illinois, as the 1949 Adams Lecturer.

Further, Dr. Doan told of the difficulties encountered in administering the Lincoln Gold Medal award. Discussion led to the following proposal.

Regulations governing the award of the Lincoln Gold Medal be changed so that in future, commencing in the year 1949, the Lincoln Gold Medal and Certificate will be awarded for the best paper with *one author*, which, in the judgment of the Board of Awards, is the greatest original contribution to the advancement and use of welding, published in an issue of THE WELDING JOURNAL during the 12-month period ending with the July issue, published before the Annual Meeting of the SOCIETY.

Reporting in behalf of Prof. Kyle, Chairman of A.W.S. Educational Committee, Dr. Doan said he had been named Chairman of a subcommittee to provide educational lectures at the National Meetings of the SOCIETY. It is his pleasure to report he had approached Dr. Robert D. Stout, Dept. of Metallurgical Engineering, Lehigh University, and found him willing to give this year's series of lectures. It will comprise three lectures of $1^1/_2$ hours each, on the subject "The Metallurgy of Arc Welds in Steel."

The Educational Committee accepted this offer and recommended to the Board of Directors that arrangement be made to conduct this educational lecture course at the Annual Meeting this year.

The Board voted favorably upon recommendation of the Educational Committee that an educational lecture series be conducted during the Annual Meeting of the SOCIETY.

Approval of Revised Rules and Proposed Tentative Specifications Recommended by T.A.C.

On recommendation of T.A.C. and with information from the Chairman of that Committee that Revised Rules for Welding Piping in Marine Construction, submitted to the Board of Directors for study under date of April 14, 1948, and that Proposed Tentative Specifications for Mild Steel Arc-Welding Electrodes, and Proposed Tentative Specifications for Low-Alloy Steel Arc-Welding Electrodes, submitted to the Board for study under date of April 26, 1948, have been approved by TAC and the respective Committees that prepared them, the Board of Directors voted approval of these rules and specifications.

Standing and Special Committee Personnel Changes

Membership.—Resignation of G. N. Sieger as Chairman of the Membership Committee was accepted, with appreciation for past services, and the appointment of H. D. Reehl, as Chairman of the Membership Committee was confirmed by the Board.

Education.—The Board endorsed recommendations of the Chairman of the Committee that H. D. Reehl be added, and G. N. Sieger be retained, as members of the Committee.

Convention.—Because of change in the Secretaryship of the Philadelphia Section, it was announced that R. A. Guenzel replaced K. W. Ostrom as a member of the Convention Committee.

A.W.S. Organization.—The Board voted discharge of this Committee, with thanks.

Representation on National Research Council Division of Engineering and Industrial Research

The President was empowered to accept invitation from the Chairman of the Division of Engineering and Industrial Research of N.R.C., to nominate an A.W.S. representative for possible appointment of N.R.C. Division of Engineering and Industrial Research, for a three-year term, ending June 30, 1951; and further he was empowered to designate and apprise N.R.C. of the name of the nominee.

Status of A.W.S. Membership as of March 31, 1948

Report showing change-over in membership during the first six months of the current fiscal year was reviewed. It is anticipated that the curve will be upward for the balance of the fiscal year.

Endorsement of Application for Engineering Foundation Grant to W.R.C.

The Board acted favorably upon request

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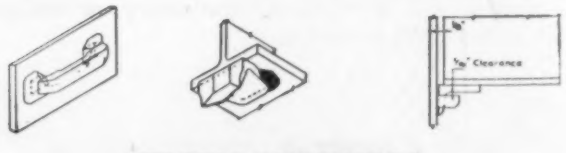

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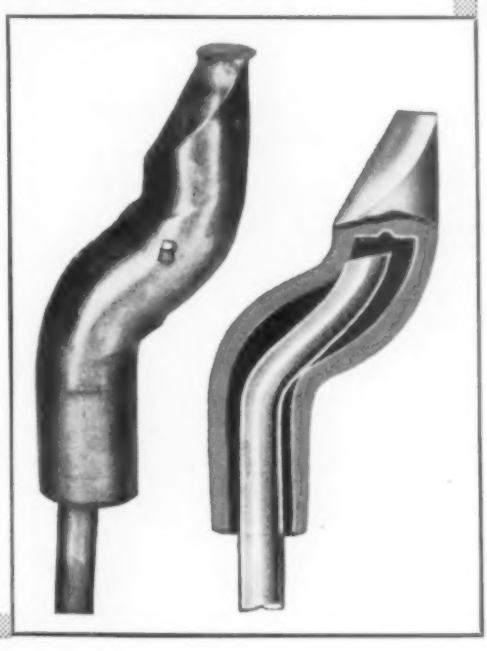

The tip at the right has as much offset as the tip at the left. It was cold bent with the water tube in place thereby bringing the water in an offset tip close to the welding face. (See cut-away drawing.)

In this way the water carries heat off faster. With the cooler tips that result you will get more uniform welds, longer tip life and a big cut in redressing time.

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of the Chairman of W.R.C. for endorsement by A.W.S. of application to Engineering Foundation for a grant of $3000 for the ensuing fiscal year, and the Board instructed the Secretary to so inform the Director of Engineering Foundation.

Application Form for Supporting Companies

Request of Mr. Sieger that some form of application blank for Supporting Companies be prepared, in order to avoid the need on part of company management for filling out six or more individual application forms to complete its subscription was considered.

The Board approved the preparation of such form and left the matter in the hands of A.W.S. staff.

PRIZE AWARD AT JOINT A.W.S.-A.F.A. MEETING

The A. F. Davis Undergraduate Award was presented at a joint meeting of the student branches of the AMERICAN WELDING SOCIETY and the American Foundrymen's Association. The Award is given to the author of the best welding article published by an undergraduate magazine. The award amounts to $200 for the winning author and $200 to the undergraduate publication which carries the winning article.

Robert Baysinger, W.E. III, won the first award with his paper "A Brief Review of Failures in Welded Vessels," which was published by *The Ohio State Engineer*. Professor R. S. Green, Department of Welding Engineering, made the presentation to Mr. Baysinger and Miss Rosella Horine, Editor of *The Ohio State Engineer*, on behalf of the Educational Committee of the AMERICAN WELDING SOCIETY.

John Beltz, Chief Engineer of the Mining Division of the Jeffrey Manufacturing Co., was the speaker for the joint meeting. Mr. Beltz discussed the design and fabrication of weldments made up of castings, plates and shapes. The talk was well illustrated by slides which were especially prepared for this program, and which were donated to the university at the conclusion of the program.

AMERICAN WELDING SOCIETY PRESENTS A. F. DAVIS UNDERGRADUATES WELDING AWARDS

The AMERICAN WELDING SOCIETY presented the cash prizes totalling $700 in the 1948 A. F. Davis Undergraduate Welding Award program during ceremonies on June 3rd at Ohio State University, Columbus, Ohio, and at the Rose Polytechnic Institute, Terra Haute, Ind.

Robert Baysinger, a Junior in Welding Engineering at Ohio State, received the first prize of $200 for his paper entitled "A Brief Review of Failures in Welded Vessels." Miss Rosella Horine, Editor of *The Ohio State Engineer*, in which the winning article was published, accepted a similar award of $200 for the magazine. The awards were presented by Prof. R. S. Green, Department of Welding Engineering, at a joint meeting of the student

Robert Baysinger

branches of the AMERICAN WELDING SOCIETY and the American Foundrymen's Association.

Mr. Baysinger is a native of Ogden Utah, and attended the University of Idaho from 1939 to 1941. During the war he was employed in welding work at Portland, Ore., by three different companies. He is the author of the "Arc Welding Manual" published by the Kaiser Co. in 1944 and of "Welding Sequences at Swan Island" published by the *The Welding Engineer* in 1946. Mr. Baysinger is married and has three children He is now em-

Mark J. Orelup

ployed as a night welder group leader Armstrong Furnace Co., Columbus.

Mark J. Orelup, a Junior in Electrical Engineering at Rose Polytechnic Institute, was presented the second prize award of $150 at the Institute's regular weekly assembly. His prize-winning paper entitled "Spot Welding of Carbon Steels" appeared in the November 1947, issue of the *Rose Technic*. Orville L. Stone, editor of the magazine, received the $150 award made to the publication. The awards were made by J. R. Stitt, Research and Welding Engineer, R. C. Mahon Co., Detroit, Mich., who is a member of the Society's Educational Committee.

Mr. Orelup was born in Aurora, Ill., and attended the Illinois Institute of Technology prior to the war. He is a veteran of three years' service with the Signal Corps and the Infantry. Mr. Orelup is a member of the track and rifle teams and also a contributing editor of the school magazine.

The certificates of award will be presented at the annual meeting of the Society at Philadelphia in October.

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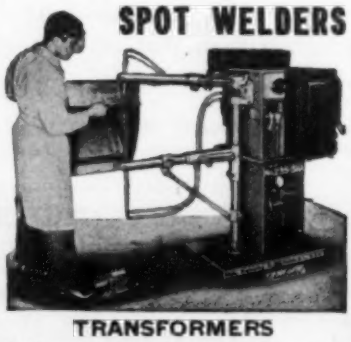

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AIR OIL, and WATER COOLED.
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NEWS OF THE INDUSTRY

ENGINEERING FOUNDATION TO SPONSOR 14 RESEARCH PROJECTS NEXT YEAR

Fourteen research projects will be sponsored by the Engineering Foundation for the year beginning in October 1948, Dr. A. B. Kinzel, chairman of the board, announced yesterday. Grants have been recommended for the continuation of 12 of the past year's 17 projects, and for the support of two new ones.

The projects will be concerned with studies in such varied fields as hydraulics, metal cutting, alloys of iron, properties of gases and gas mixtures, riveted and bolted structural joints, reinforced concrete, welding and properties of metals at different temperatures.

"In selecting projects to be supported, preference was given to those of the most fundamental nature which would not be undertaken by an industrial research organization," Dr. Kinzel pointed out. "Where projects are of interest to a group of industries the Foundation provides a limited financial support and sponsorship intended to enable the principal support of the project to be secured from interested industries and other sources."

Research is carried on in a number of universities and some engineering plants in cooperation with the Foundation's engineering founder societies: the American Society of Civil Engineers, the American Institiute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

The Engineering Foundation, with offices at 29 W. 39th St., has been engaged in important research activities for more than 30 years. In addition to sponsoring research in various fields of engineering, it also supports agencies or activities having as their objectives the advancement of the engineering profession. Among the latter is the Engineers' Council for Professional Development, a cooperative effort of eight national engineering organizations to raise professional standards of education and practice. A recent project of this organization was the preparation of standardized pre-engineering examinations which are now being widely used to guide prospective engineering college students.

"The Foundation would welcome gifts and bequests, the income of which would be used to support carefully chosen research projects," Dr. Kinzel announced. "It has an endowment at present of a little less than a million dollars, which is inadequate to enable it to embrace all the opportunities which come to it to aid in fruitful research."

NEW A.S.M.E. OFFICERS NOMINATED AT SUMMER MEETING, MILWAUKEE

James M. Todd, New Orleans consulting engineer, was nominated as the next president of the American Society of Mechanical Engineers during the semi-annual meeting in Milwaukee. His name heads a slate of new officers, including several regional vice-presidents and directors-at-large, submitted by the nominating committee. Nomination is tantamount to election since only one name is presented for each office.

Formal election will take place in the fall by letter ballot of the membership, which totals more than 25,000 engineers throughout the United States. The 1948–49 term will begin at the end of the annual meeting next December.

Mr. Todd, who will succeed E. G. Bailey of New York as President of the engineering society, is in private practice as a consulting mechanical and electrical engineer at 217 N. Peters St., New Orleans. Born in Franklin, La., 1896, he was graduated from Tulane University, New Orleans, in 1918 with the degree of B.E., and in 1930 received the degree of M.E.

During World War I he served in England and France as a lieutenant of engineers. After the war he became chief engineer of Penick and Ford, Ltd., formerly of New Orleans and now of Cedar Rapids, Iowa. Later he was associated with A. M. Lockett and Co., mechanical engineering contractors of New Orleans, resigning to engage in private practice.

Previously he held offices as manager and as vice-president of the A.S.M.E., and served on many of the important committees. He became a Fellow of the Society in 1944.

Other Officers Named

Other officers nominated: As regional vice-president—Arthur Roberts, Jr., chief engineer, Lynchburg Foundry Co., Lynchburg, Va.; Forrest Nagler, chief mechanical engineer, Allis-Chalmers Mfg. Co., Milwaukee; Carl J. Eckhardt, professor of mechanical engineering and superintendent of utilities, University of Texas, Austin; Albert R. Mumford, development engineer, Combustion Engineering Co., 200 Madison Ave., New York (renominated).

As director-at-large—Jacob A. Keeth, manager of power production, Kansas State Power and Light Co., Kansas City, Kan.; Ralph A. Sherman, assistant director, Battelle Memorial Institute, Columbus, Ohio.

The nominating committee which selected the new slate is headed by Roland W. Flynn, division lubrication engineer, Gulf Oil Corp., New York.

FIFTY-FIRST ANNUAL MEETING A.S.T.M., JUNE 21–25, DETROIT, MICH.

With more than 135 technical papers and reports of the Society's committees, some 360 committee meetings, and an extensive exhibit of testing and research apparatus and laboratory equipment, the fifty-first annual meeting of the American Society for Testing Materials again emphasized the importance of work in materials.

As a result of recommendations by the Society's committees which are responsible for initiating and carrying through work on specifications and tests for materials, there were 52 new tentative specifications and tests approved and about 70 existing tentatives are to be adopted as standard subject to Society letter ballot during the summer.

Total registration for the week was something over 1775, compared with the figures of 1835 for the 1946 meeting in Buffalo and 1786 for the Annual Meeting in Atlantic City in 1947, a year ago.

Technical Symposiums and Sessions

An audience of 250 attended the Round-Table Discussion on Ultrasonic Testing in which leading authorities participated. There were two prepared discussions giving fundamental background, and a number of others who use this interesting method of determining the soundness of metal covered the practical applications. Also of interest to the metallurgist was the Symposium on Metallography in Color, with latest developments covered in several papers. It is hoped these will be published later in the year.

The Symposium on Magnetic Testing, in two sessions, with nine papers brought up to date the art and science in this field. The symposium described some of the problems encountered and the methods that are used to overcome them.

Other symposiums and sessions of specific interest in the field of metals covered the deformation of metals as related to forming and service, and effect of temperature on the properties of metals.

The Charles B. Dudley Medal named after the Society's first President, and awarded to the author or authors of a paper in the field of research, was presented to N. L. Mochel, Manager, Metallurgical Dept., Westinghouse Electric Corp., and P. R. Toolin, Research Engineer, Mechanics Dept., Westinghouse Research Labs., for their important paper presented in 1947 on "The High-Temperature Fatigue Strength of Several Gas Turbine Alloys."

Marburg Lecture

The Society's Marburg Lecture, which commemorates the name of the Society's first Secretary and recognizes his pioneering work in stimulating the presentation and discussion of papers and reports in the field of materials, was delivered by Dr. P. C. Aebersold, Atomic Energy Commission. He covered "Isotopes and Their Application in the Field of Industrial Materials," and stressed to the large audience present the tremendous possibilities of these new materials which are now available for science and industry to use in a wide variety of applications.

New Officers and Honorary Members

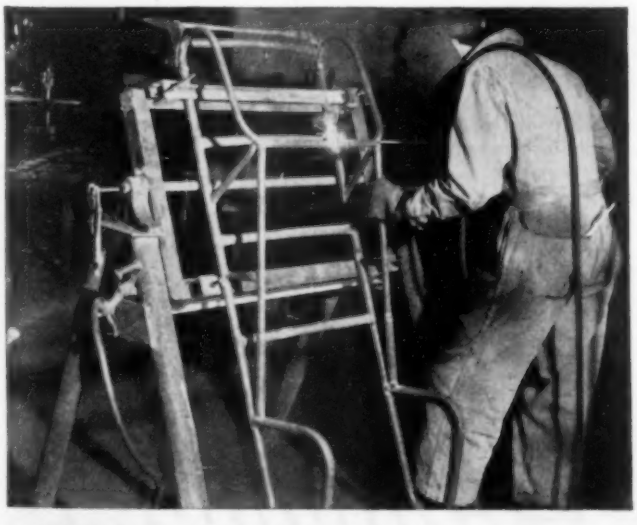
Richard L. Templin, Assistant Director of research and Chief Engineer of Tests, Aluminum Company of America, New

New Electrode Solves Many Welding Problems

Lincoln "Shield-Arc LH-70," for mild steel and hard-to-weld steels, operates in all positions, a.c. or d.c.

EASILY MACHINED. This manufacturer of tire molds, made of high-sulphur (free machining) steel, has simplified repair work with "Shield-Arc LH-70" because its deposits are easily machined and dense. Ribs in mold shown are being built up along edges due to machining error. Welded ribs will then be machined to proper size.

BANISHES POROSITY. In fabricating sprockets, this manufacturer welds together a disc of mild steel plate and a hub of round cold-rolled stock as shown. Formerly welds were porous; with "Shield-Arc LH-70," they are dense and smooth.



ELIMINATES HEAT-TREATMENT. In the welding of high-carbon, thin-walled tubing, this Company had to use costly heat-treating. This has been eliminated by welding with "Shield-Arc LH-70." Similar benefits are being obtained for high-tensile steels and welds to be porcelain enameled without annealing.

EASY . . . FAST. Many shops are using "Shield-Arc LH-70" for mild steel. On bevelled horizontal butt joints (above), it eliminates need for or materially reduces back-chipping and it can be used with easy straight-drag technique—no whipping required. On down-hand square butts (below), "LH-70" gives 15% to 20% faster welding because of ability to use higher current and get deeper penetration.

The above is published by LINCOLN ELECTRIC in the interests of progress. For further information on "Shield-Arc LH-70," write The Lincoln Electric Company, Dept. 108, Cleveland 1, Ohio.

Advertisement

Kensington, Pa., was elected President for 1948–1949, succeeding T. A. Boyd, Research Consultant Laboratories Division, General Motors Corp., Detroit, Mich., who continues on the Board of Directors as Past-President for three years. L. J. Markwardt, Assistant Director, U. S. Forest Products Laboratory, Madison, Wis., is the new Vice-President to serve with the Senior Vice-President J. G. Morrow, Metallurgical Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario, Can.

The new members of the Board of Directors are as follows: Leslie C. Beard, Jr., Chemist, and Assistant Director of Laboratories, Socony-Vacuum Oil Co., Inc., New York, N. Y.; Simon Collier, Director of Quality, Johns-Manville Corp., New York, N. Y.; Theodore P. Dresser, Jr., Chief Engineer, Abbot A. Hanks, Inc., San Francisco, Calif.; Howard K. Nason, Associate Director, Central Research Dept., Monsanto Chemical Co., Dayton, Ohio; Edgar W. Fasig, General Superintendent, Lowe Brothers Co., Dayton, Ohio.

1949 Meetings

It was announced that the 1949 Annual Meeting of the Society will be held in Atlantic City during the week of June 27–July 1. The 1949 Committee Week and Spring Meeting will be held in Chicago during the week of February 27–March 4. In addition, a number of A.S.T.M. technical committees will either hold group sessions separately or may combine with other committees in the same field for three- or four-day meetings in the fall or spring.

A.M.C.A. MEETING

The American Metal.izing Contractors Association, which was organized in St. Louis in December 1947, recently held their second meeting at Cleveland, Ohio. Seven new members were accepted into membership. These new contract shops were: Metalweld, Inc., Philadelphia, Pa.; Forney's, Inc., New Castle, Pa.; Harbin Welding Co., Cincinnati, Ohio; Akron Sandblast Co., Barberton, Ohio; Fulton Foundry and Machine Co., Cleveland, Ohio; C. Park and Co., Newport Beach, Calif.; and Atomized Metals, San Francisco, Calif. Other concerns present, who were founders of the Association, were: Alloy Welding and Mfg. Co., Tulsa, Okla.; Metallizing, Inc., Chicago, Ill.; Metal Spraying Corp., Milwaukee, Wis.; Dix Engineering Co., Inc., Detroit, Mich.; Tranter Mfg. Co., Pittsburgh, Pa.; Thornton Co., Cleveland, Ohio; and John Nooter Boiler Works Co., St. Louis, Mo.

A.M.C.A. is entirely concerned with the application of the Metallizing process by commercial contract. Its members are those concerns whose business it is to employ metallizing equipment for the contract repair of worn machine parts, the application of corrosion and heat resistant coatings, and for such production applications of sprayed metal as are suitable for metallizing. Its purposes are as follows:

1. To promote the welfare and prosperity of the Metallizing Contract Industry, and the increasing interest of the public in matters pertaining to the industry.
2. To foster, through lawful educational means, mutual relations of trust, understanding and cooperation among the members, and among the industries they serve.
3. To collect, preserve and disseminate statistical data pertaining to the industry.
4. To exercise its powers for scientific and educational purposes, but not for pecuniary profit in any form.

Specifically, these objectives have been implemented by the creation of a comprehensive data file whereby members write detailed reports on the more difficult and complicated jobs which they have successfully performed. These reports include special procedures, time studies, service records and other pertinent data. They are reproduced by the Secretary's office and transmitted to all members.

Standards are being set up, to which all members will conform thus assuring industry of the highest quality workmanship possible.

Meetings are scheduled for twice each year. Thus, for the first time in history, the contractors can become personally acquainted, exchange experiences and hear speakers whose interest lies in the metallizing field.

Among the speakers heard at the Cleveland Meeting were H. S. Ingham, Vice-President of the Metallizing Engineering Co., Inc., who discussed the new Sprabond method of attacking metallized coatings; J. A. Menefee, Sales Manager of the Metallizing Company of America, Chicago, Ill., who demonstrated his concern's new Metallizing unit, the Mogulectric; W. H. Williard, of the Detrex Corp., Detroit, Mich., who presented the problems encountered in the metallizing of degreasing equipment. Downs, of the Wire Products Div., and Kaufmann, Metallurgist, both of the Crucible Steel Co., discussed the qualities and properties of the various wires required by the metallizing industry.

Wm. H. Fatka; of Chicago, Ill., is President of A.M.C.A. Harry W. Moore, Tulsa, Okla., serves as Vice-President. Walter B. Meyer, Secretary-Treasurer of the Association, maintains an office at 773 Brownell Ave., St. Louis, Mo. Thomas H. Lufkin, Pittsburgh, Pa., has been named chairman of the Board of Directors.

WELDING CLINIC REVEALS NEW TECHNIQUES SOLVING OLD WELDING PROBLEMS

More than 2600 industrial executives attended a three-day welding clinic, May 13th, 14th and 15th, to watch twelve metal industry leaders,* demonstrate new welding techniques and equipment at the New York headquarters of Whitehead Metal Products Co.

Feature of the session was a wealth of welding data "not in the textbook," unpublished information and tricks of the trade which came out in welding demonstrations on actual problems presented by metal users and their representatives.

The demonstrations of inert-gas welding† were typical examples. Demonstrators answered hundreds of questions about this revolutionary welding method which opens the field wide for successful welding of magnesium and aluminum. Atomic-

* Air Reduction Sales Co., Aluminum Company of America, The American Brass Co., General Electric Co., Handy & Harman, Induction Heating Co., The International Nickel Co., The Linde Air Products Co., Lukens Steel Co., Sciaky Bros., The A. O. Smith Co., and Westinghouse Electric Co.

† Demonstrated by Air Reduction Sales Co. and The Linde Air Products Co.

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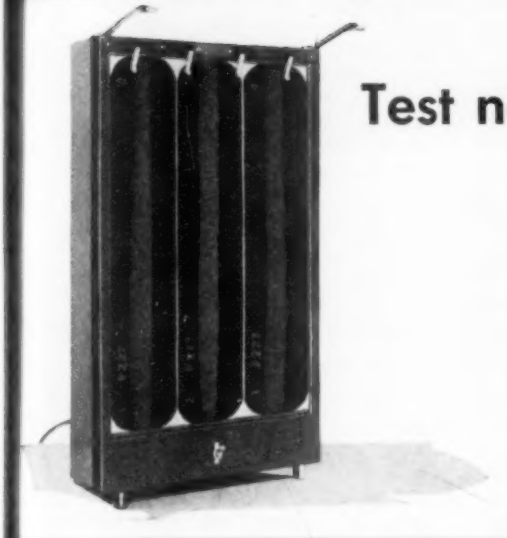
Improve over-all welding quality . . .

Constant improvement in over-all welding quality is due largely to the welder's adoption of new and proved practices and technics. In this, radiography is contributing importantly by providing records that help determine good practice by showing the internal conditions of the weld without destructive testing.



Test non-destructively with radiography . . .

Radiographic examination of welds helps develop sound welding technics faster . . . helps determine the soundness of the weld itself. It assures that the weldment has satisfactory penetration, is well fused, and is free from objectionable inclusions, porosity, and other irregularities. Often the information obtained from radiographs of the first job will decide welding procedure on an entire production run.

For maximum radiographic visibility— use Kodak Industrial X-ray Films . . .

Kodak Industrial X-ray Film, TYPE A . . . for x-ray and gamma-ray work in sections where fine grain and high contrast are desirable for maximum sensitivity at moderate exposure times.

Kodak Industrial X-ray Film, TYPE K . . . designed for gamma-ray and x-ray radiography of heavy steel parts, and of lighter parts at limited voltages where high film speed is needed.

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Kodak Industrial X-ray Film, TYPE F . . . with calcium tungstate screens—primarily for radiography of heavy steel parts. For the fastest possible radiographic procedure.

They provide the high radiographic sensitivity—the combination of speed, contrast, and fine grain required for the detail visibility you need in critical examination of welds.

For complete information on the types best adapted to your job, see your local X-ray dealer or write to

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hydrogen welding methods were also employed‡ on thin-sheet work involving the high-nickel alloys.

In many instances manufacturers brought their own pieces to be welded or brazed at one of the dozen booths on the floor by a choice of techniques covering gas, electric, heli-arc, induction, gas and air, flame cutting and resistance welding methods. Problems ranged from the simplest metal-joining questions to those involving glass and ceramics, with successful answers being supplied in each instance.

The demonstrations ran continuously for nine hours on each of the first two days and four hours on the last day—a Saturday—drawing crowds from eight Eastern states. Foreign interest was represented by delegates from Brazil, Uruguay, Argentina and Mexico. Over-all spectator reaction showed a marked enthusiasm for the "noncommercial" character of the show, with an overwhelming demand for more such sessions, to place new welding developments periodically within reach of every principal in the industry.

‡ Demonstrated by the International Nickel Co.

WELDING CYLINDERS AND TRUCKS

A recent announcement by Lewis B. Adams of Adams Manufacturing and Supply Co., Los Angeles, tells of greatly increased facility. Adams produces a line of welding cylinder and materials handling trucks. Factory and office buildings are being enlarged to nearly twice former floor space. New machine tools and equipment are being added to make greater "production line" treatment. New hand truck types will be added to the nearly complete line. In accordance with the policy of distribution through welding supply jobbers, more distributors are being added in other parts of the country.

LINCOLN TO HAVE NEW PLANT

Plans for the construction of a complete new manufacturing plant and headquarters offices for the Lincoln Electric Co. at E. 178th St. and St. Clair Ave., Cleveland, have been announced by James F. Lincoln, president.

Preliminary studies for the new plant, which will represent an investment of more than ten million dollars, are being developed by engineers of The Austin Co. It will be situated on a 50-acre tract and will ultimately provide about 25 acres of floor space under one roof.

The new facilities will completely replace the company's present plant at 12818 Coit Rd., which will be disposed of in the light of traffic problems presented by establishment of the new Lake Shore freeway alongside the plant.

The project was announced following a conference with Mayor Thomas A. Burke of Cleveland, concerning construction of a $300,000 storm sewer which the City has agreed to install to serve the new plant.

ALUMINUM FUEL-OIL STORAGE TANKS NOW ACCEPTED BY UNDERWRITERS

Based on results obtained by engineers of Reynolds Metals Co. and other aluminum producers working with manufacturers of 275-gal. aluminum fuel oil storage tanks, Underwriters' Laboratories, Inc., has recently issued a set of standards covering the use of flat aluminum sheet for the manufacture of such tanks. This acceptance of aluminum was issued under Subject 80-A, entitled, "Standard for Aluminum Inside Storage Tanks for Oil Burners." Copies of the set of standards may be obtained by addressing Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago, Ill.

This acceptance of aluminum for the manufacture of fuel oil storage tanks permits aluminum to make new contributions to better home heating. Already aluminum is playing an important role in the manufacture of hot water heating equipment, stove parts, furnace jackets and ducts for heating pipes. It is also being widely used in the manufacture and installation of ventilating and air-conditioning equipment.

The bulletin announcing the Underwriters' requirements indicated that a number of aluminum alloys in a variety of tempers were acceptable for this new application. Among the alloys designated as satisfactory for the tanks are 3S, 4S, 52S, 61S and Utility Sheet in all tempers except the annealed (0) temper. 2S in tempers harder than "-H14" (half-hard) was also designated as satisfactory.

The minimum thickness of the sheet from which the head and shell are to be manufactured has been set at No. 10 B. & S. Gauge, which is 0.102 in. A tensile strength of 18,000 psi. is indicated as the minimum for the sheets to be used for making the tanks. The manufacturer of the aluminum sheet is to make possible the positive identification of the sheets used as to alloy and temper. Marking of the sheets at the aluminum supplier's mill is recommended.

The standards require that the heads and seams must be welded with a $^1/_2$-in. lap or with butt-welded seams. Argon gas-shielded arc welding is preferred. Other methods of fusion welding are also acceptable, but the standards specify that all welding flux be removed either by acid treatment or by cleaning with a wire brush and warm water.

The acceptance applies to tanks with a maximum capacity of 275 gal. If the tanks are not cylindrical, the form must demonstrate under test that it provides sufficient strength and tightness.

In addition to the supply connection (which may be in one end near the bottom of the tank for gravity feed) there must be a minimum of three pipe connections in the top of the tank. Welded to the tank, these pipe connections are for fill, vent and liquid-level gage attachments. Connections for use with aluminum tanks may be either cast or wrought aluminum in an alloy suitable for welding.

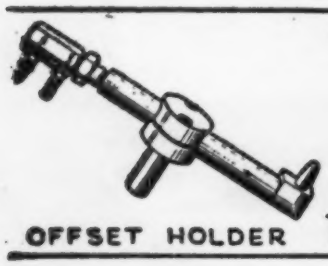
Following assembly, each tank must be tested for leaks by the internal application of air pressure (5–10 psi.). An internal hydrostatic test at a pressure of 25 psi. is also applied. This test is much more severe than actual service conditions.

WORLD'S LARGEST PIPE BENDING MACHINE IN OPERATION

The bending of pipe large enough to garage a limousine—a feat most engineers would scoff at as "impossible"—has been proved both possible and practical by a new process announced by the M. W. Kellogg Co., engineers and steel fabricators of Jersey City, N. J.

In a statement issued recently Alex Kidd, Vice-President of the Kellogg Co., made known that pipe bends larger than were ever made before were being made with the new machine and that these bends were not only passing the strictest production tests but were found to be of higher quality than bends fabricated by the usual welded segment procedure.

During the war, the advent of giant petroleum refining plants necessitated the use of large-diameter piping. Yet, at that time, bending apparatus and procedures throughout the country were developed only for pipe diameters up to 34 in. Giant bends larger than this diameter had to be fabricated of segments welded together—an expensive and time-consuming operation. In service, such bends showed a tendency toward "stress corrosion," a phenomenon expressing itself in accelerated corrosion and cracking at points where internal stresses were unavoidably locked in as by welding of the five or six segmental sections of the bend. Although the development of stress corrosion cracks could be minimized by the use of stress-relieving



PAGE *Welding* ELECTRODES

Welding STAINLESS?

We found out a long time ago that welding stainless steel is not always as simple as it looks. So we set out to study the problems and find the answers.

Since then we have developed the complete line of PAGE-Allegheny Stainless Steel Electrodes and Gas Welding Rods. More important, we have collected—from our Field Service men, our distributors and their customers—a valuable fund of information about welding techniques. We have been able to offer real help to many fabricators of stainless steel.

If you are welding Stainless, we suggest that you . . . . . .

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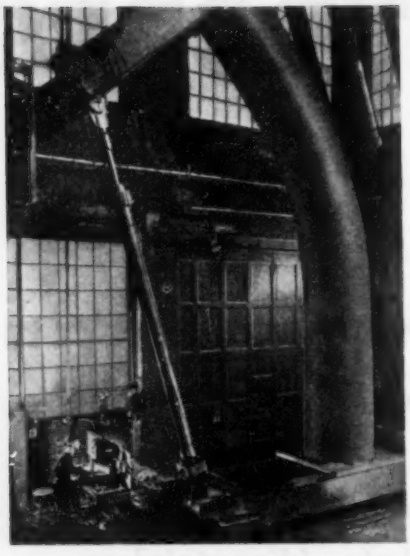

A 50-In. Diameter Pipe Bend—Largest One Piece Bend Ever Made—in a Newly Developed Apparatus at the Jersey City Works of The M. W. Kellogg Co., Petroleum and Chemical Engineers.

heat treatments, all industry realized that it would be far more efficient to actually make a continuous, smooth bend from one piece of large-diameter pipe.

After two years of research and development Kellogg engineers perfected a bending process and apparatus which can handle pipe diameters up to 100 in.—as large as will be required anywhere in the foreseeable future.

The method bends pipe in the hot state under hydraulic pressure. It is adaptable to small and large diameters, to thin and thick-walled pipe, and to short or long radius bends. It is currently being employed to fabricate 50-in. pipe bends for the carrier lines of large oil-refining units.

The great value of the new process lies in the improved product, in the superior performance and reduced maintenance to be gained from uniform pipe contours both inside and out. The smooth even bend markedly reduces or eliminates entirely erosion and eddy currents due to sudden changes in direction or to sharp-cornered fillets which act as stress raisers. And because the pipe is bent hot and slowly cooled, the stress remains uniform throughout the bend thereby minimizing the effects of stress corrosion previously mentioned.

The new pipe-bending process may be profitably used wherever a change in direction of a pipe line over 34 in. in diameter is required. There is no other machine today which can bend pipe in this range. In addition to petroleum-refining applications other probable uses of the new process include the following:

1. Steam Power Plants for circulating water pipe. Mitered (segmental welded) bends are currently used.
2. Manufactured Gas Plants where large-diameter pipe is employed as a transportation artery for the gas over long distances.
3. *Large Wind Tunnels* and other similar testing plants.
4. *Hydroelectric Power Plants* for penstocks (large-diameter pipe which conveys water from the flumes to a central turbine).

LARGE PRESSURE VESSEL

The largest welded vessel ever produced at the Bethlehem plant of Bethlehem Steel Co., a 155-ft. creosote autoclave of 8 ft. inside diameter and weighing 116 tons, has just been shipped to Texas Creosoting Co., Orange, Tex. The vessel, built according to A.S.M.E. U201 Code, was designed for 275 psi. and will operate at 225 psi. max. working pressure and 650° F. The shell was made of 0.96-in. A212 grade B firebox quality steel plate, and all intersections of circumferential and longitudinal welds were X-rayed.

In shipping, three flat cars were used for loading the main vessel, with a fourth car serving as idler and carrying the two end covers. Special blocking had to be used to secure the vessel on the cars.

FILTER-AIRE FOR CRANE CABS

This new Filter-Aire, recently brought out by The Lintern Corp. of Berea, Ohio, is claimed to be ideal for cabs of foundry cranes, weld shop cranes, and in many

locations in steel and large industrial plants exposed to waste gases where mechanical refrigeration is not required and atmospheric conditions are bad.

The dimensions are 60 x 14 x 26 in. The unit is placed easily in the conventional type of cab (after it is enclosed) against the back wall. The unit is available for a.-c. or d.-c. operation.

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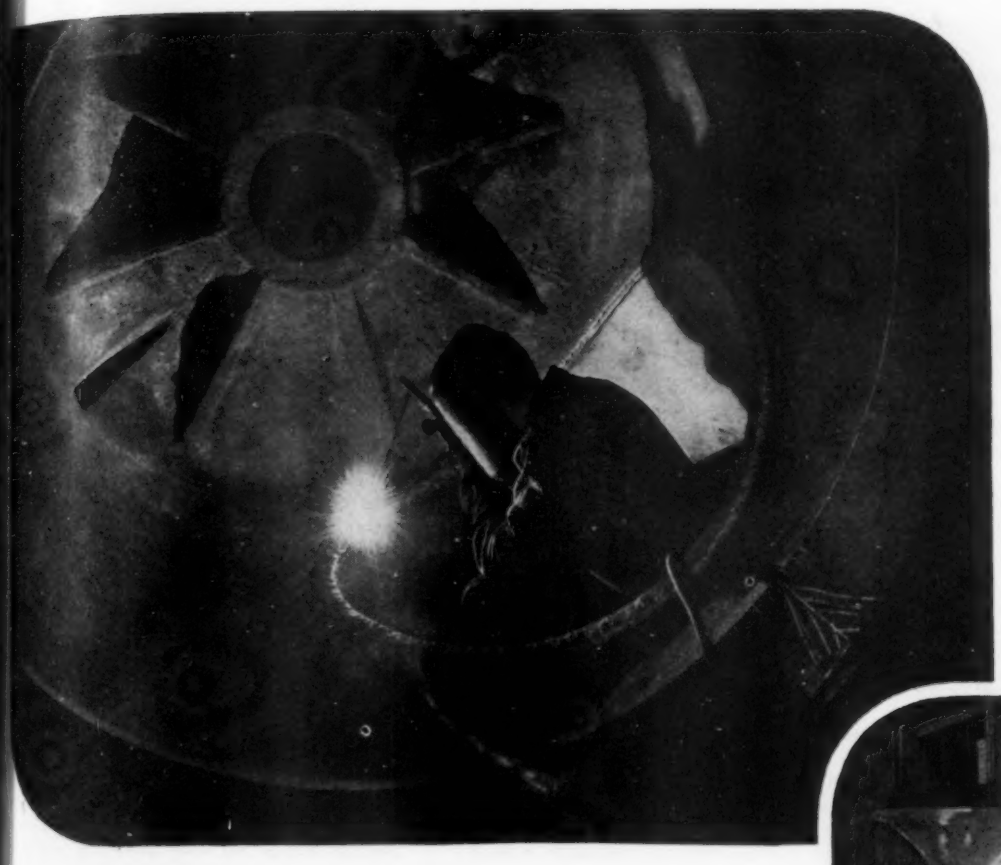
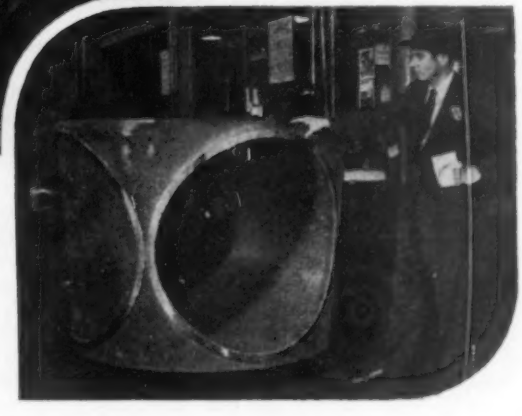


Applying Monel overlay on a 42" valve body. 22 pounds of Ni-Rod, and 90 pounds of "130X" Monel electrodes are required for a single valve body.

• • •

Plug with Monel seat rings for 42" Chapman Cone Valve. Finished plug weighs 7,550 pounds.



How they made Monel overlays on iron aqueduct valves... to help insure drinking water for millions

"Give us MONEL seats and seat rings on these big valves. We're installing them 400 feet underground and we want to cut corrosion-erosion troubles to a minimum!"

That's what New York Board of Water Supply engineers told the Chapman Valve Company of Indian Orchard, Mass.

The job was the fabrication of fourteen cone type valves to be used in effluent chambers of the Kensico and Delaware Aqueducts. The valves were designed to control the flow of water in mains 16" to 42" in diameter. Their size was huge. The 42" valves, completed, weighed 30,000 pounds each!

The valve bodies and plugs were cast of Ni-Cr-Moly iron. Chapman Valve Company technicians, after studying the problem, decided to construct the required Monel* seats and rings directly upon valve and stem bodies by the welded overlay method. Here is how the job was done:

The areas to be overlayed were cleaned thoroughly by sandblasting. This was the only preparation necessary, since Ni-Rod* electrodes were to be used for first passes.

The foundation layers were applied with 3/16" Ni-Rod electrodes. Each layer was set by peening before the next was applied. After the iron surfaces had been completely covered with Ni-Rod deposit, the Monel overlays were applied in the same manner, using 3/16" "130X" Monel electrodes.

When the required depth of overlay had been reached, the castings were sent to the shop where seats and seat rings were machined to dimension.

The Chapman Valve Company reports that both Ni-Rod and "130X" Monel electrodes gave completely satisfactory performance. They were free-flowing, gave stable arcs, and most important of all—produced sound, crack-free non-porous welds.

If you have not yet discovered the outstanding time-and-money-saving advantages of INCO welding materials, investigate without delay. Write for list of distributors and your free copy of *"INCO Electrodes, Wires, Fluxes."*

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METALS CONGRESS

More than 85% of the 200,000 sq. ft. of available floor space in Philadelphia's three great exhibit areas have been reserved for the coming National Metal Exposition, Oct. 25 to 29, 1948.

A total of 350 exhibitors have already been assigned space for the metal industry's largest exposition, according to W. H. Eisenman, managing director of the exposition and National Secretary of the American Society for Metals, sponsors of the event. Because of the unprecedented development in industrial production during the three postwar years, it is anticipated that the entire available areas will be reserved well in advance of the opening date.

The 1948 Metal Show at Philadelphia will feature "A Salute to Alloy Steel" as a tribute to these important steels and in celebration of the diamond jubilee in their history. Strictly an American accomplishment, the development of alloy steels has been one of the outstanding credits to the metallurgists of our country, their greatest advances being a parallel to the thirty years of A.S.M. service to the metals industry.

Because Philadelphia is a major center of the metals industry, the October Congress and Exposition will include two days of preconvention sessions at which large numbers of interested engineers and technical personnel will attend a series of meetings covering "The Cold Working of Metals."

Since the annual sessions of four major technological societies will open on Monday, October 25th, simultaneously with the opening of the Exposition, it is expected that most of the out-of-Philadelphia-area visitors will attend the Exposition during the week of these sessions.

The National Metals Exposition, sponsored by the American Society for Metals, will be held concurrently with the National Metals Congress. In addition to the A.S.M., technical meetings during the week will be held by the AMERICAN WELDING SOCIETY, the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers and the Society for Non-destructive Testing.

LINCOLN FOUNDATION PAPERS PUBLISHED

Through an oversight THE JOURNAL neglected to give suitable credit to the James F. Lincoln Arc Welding Foundation for the paper by P. F. George on "Eliminating Cracking in Magnesium Arc Welds," which appeared in the June *Welding Research Supplement*. This paper contains data and illustrations from a study submitted to the Foundation in its recent $200,000 Design for Progress Award Program for reports on advances and improvements made by the application of arc welding in design, fabrication, construction and maintenance.

DIFFICULT PROPANE DECARBONIZING TOWER JOB COMPLETED

Two propane decarbonizing towers, each 12 ft. in diameter, 75 ft. in length and *2⅛ in. in wall thickness* have recently been completed at The M. W. Kellogg Shops in Jersey City. They will be shipped overseas for installation in two foreign refineries.

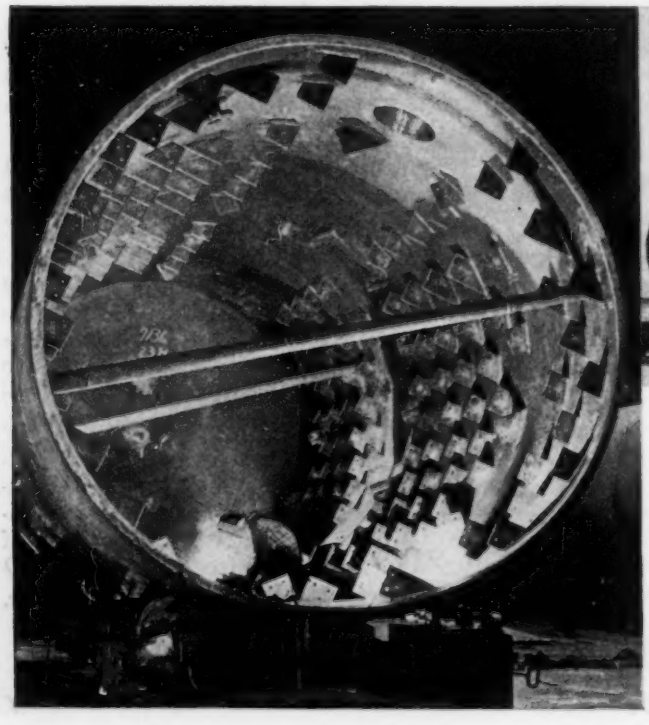
Because of the rare combination of plate thickness and vessel diameter, fabrication of the 175-ton vessels required special equipment and manufacturing skill of the first water.

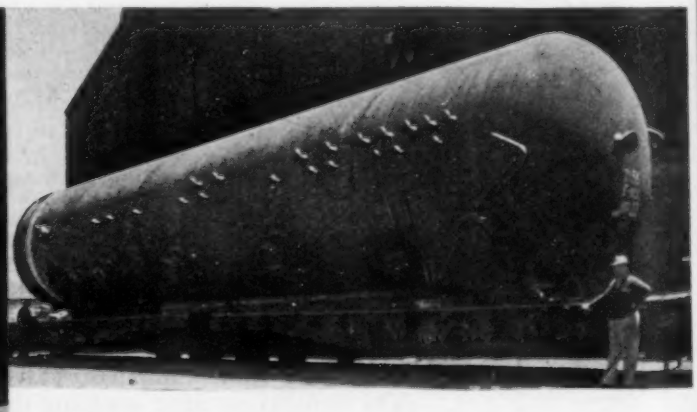
The specification of 2⅛ in. for wall thickness is particularly noteworthy since most pressure vessels are less than 1½ in. in thickness. Every quarter-inch added to wall thickness introduces bending, welding and handling problems far greater than those expected from vessels of smaller proportions. Pressure vessels employing 2⅛-in. steel plate are rarely made as large as 12 ft. in diameter and 75 ft. in length because of the extreme difficulty of fabrication.

The unusually thick 2⅛-in. wall of these two vessels was required to withstand a high internal pressure—approximately 500 psi.—and additionally, to provide ⅛ in. of corrosion allowance due to the presence of active sulphur compounds in the reduced crude oil which will be processed. The vessels were tested hydrostatically to 900 psi. To provide an ample margin of safety they were designed with a safety factor of five, that is, to withstand five times the actual working pressure of 500 lb.

The principal material of construction was a high-tensile strength, carbon-silicon steel which, with a tensile strength of 70,000 psi., is approximately 30% stronger than usual pressure vessel steels. This strong carbon-silicon steel necessitated precise welding control to prevent cracking of the weld or metal adjacent to the weld and to develop a weld strength equal to that of the plate. Kellogg metallurgists had previously worked out the optimum preheat range for this steel by welding under various preheat temperatures and then X-raying and microscopically examining the metal. This preheat range was accurately adhered to by measuring the metal temperature during shop welding of the vessels.

The thickness of the plate, too, required approximately 24 layers of weld metal in each joint, each layer deposited after careful removal of the slag from the previous layer. All principal joints were welded automatically by a continuous submerged-arc process, with machines incorporating novel mechanical design





(Above) A seventy-five foot petroleum refining vessel starting first leg of its journey to a foreign installation. Called a propane decarbonizing power and destined for a pressure operation of 500 psi., the 175-ton vessel combines a 12-ft. diam. with an unusual steel plate thickness of 2⅛ in.

(Left) The sleek exteriors of petroleum refining vessels often hide complicated "innards". Here is a stage in the fabrication of a section of a 75-ft., 175-ton propane decarbonizing tower destined for a foreign refinery. The welder is installing brackets for the support of trays and pipe coils.

FOR SHIELDED ARC AUTOMATIC WELDING

THE NEW AND REVOLUTIONARY ELECTRODE FOR AUTOMATIC ARC WELDING

RACO Composite Type A is a heavily coated electrode in coils, providing the same physical results as heavily coated manual electrodes. With RACO Composite Type A, extremely high speeds can be obtained.

It can be used with all standard automatic arc welding heads with the addition of adapter and contact device illustrated.

RACO Composite Type A can be had with any of the following coatings—A.W.S. 6012; 6020; 6030; 7020; 7030, and corresponding high tensile grades A.W.S. 8020; 8030; 9020; 9030; 10020; 10030. This electrode can also be furnished in three grades of hard surfacing material for building-up—RACO 25 (20-25 Rockwell C), RACO 45 (40-50 Rockwell C) and RACO 55 (50-60 Rockwell C). RACO Composite Type A Electrode is furnished in the following sizes: No. 8 (approx. ⅛"), No. 7 (approx. 5/32"), No. 6 (approx. ¼"), No. 5 (approx. 7/32"), No. 4 (approx. 3/16"), and No. 3 (approx. 5/32"). Coils are 36 inches I.D., and weigh 100 to 150 pounds net.

LIGHTLY COATED AUTOMATIC ELECTRODES:—

RACO Types "D", "M", M-9 (Knurled), Plain Mill Finish and Copper Coated Wire in coils.

We draw a full line of copper coated oxy-acetylene welding wires. Furnished in coils and straightened and cut lengths.

We further manufacture a complete line of heavy coated manual electrodes for welding:—Mild Steel—High Tensile Steels—Stainless Steel—Manganese Steel—Cast Iron—Nickel—Monel—Inconel and Aluminized Steel.

Write for full information.

The REID-AVERY COMPANY
INCORPORATED
DUNDALK • BALTIMORE 22 • MARYLAND
SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

features. This procedure provided uniformly good weld quality while saving more than 50% of the welding time which would have been required by manual welding. The welding of the external and internal attachments was performed manually using a ferritic low-hydrogen type of electrode developed during the war for the welding of armor plate without cracks.

Inspection of welds included the radiographing of all main butt joints, using a 400,000-kva. X-ray unit; and magnetic particle inspection of all strength welds not radiographed. In addition to this nondestructive inspection, test plates were welded as continuations of the longitudinal seams, and were tested destructively to verify joint strength and ductility. Tests made on these plates were in accordance with the requirements of Lloyds Register of Shipping Rules for Welded Pressure Vessels. Tests included all-weld tensile, joint tensile, bend, impact, hardness and photomicrograph specimens. One bend specimen reached 83% without failure although the minimum requirement is only 30%.

Since welding unavoidably leaves the vessel with a nonuniform grain of at least three different sizes—weld metal, parent metal adjacent to the weld and parent metal far from the weld—the finished vessels were stress relieved in specially constructed furnaces.

Because of its excessive weight and thickness, the flat plate for these 75-ft towers was hot rolled in six equal sections again with control of bending temperature using an optical pyrometer. Despite the thickness of the plate, the sections were rounded up to be well within the tolerances allowed by the A.P.I. and A.S.-M.E. Codes. The six sections were then welded together.

The interior of the vessels (see photo) contains numerous supporting brackets for steam coils, distributor troughs and baffles. These were all installed prior to stress-relieving treatment. All nozzles and pressure connections on the towers were Magnafluxed to insure freedom from cracks.

PERSONNEL

LINCOLN PROMOTED

C. D'W. Gibson, vice-president in charge of sales, Air Reduction, has announced the appointment of John J. Lincoln, Jr., as manager of the railroad department with headquarters in New York. The railroad department maintains regional sales offices at New York under C. B. Armstrong, and at Chicago under D. J. Williams, with divisional offices at Cleveland and St. Louis.

John J. Lincoln

Mr. Lincoln joined Air Reduction in 1924. After sales work in several districts, he became manager in Pittsburgh in 1934, then moved to New York as Regional Sales Manager in 1938. Since 1945 he has been director of sales services.

STERNKE MADE VICE-PRESIDENT

Richard W. Sternke has been elected vice-president of the Lakeside Bridge & Steel Co., Milwaukee, Wis. Hispromotion climaxes a record of 32 years service with the company. During this time he has been intensely interested in the promotion of welding. He was one of the organizers and is a past chairman of the Milwaukee Section of the AMERICAN WELDING SOCIETY. In addition to his interest in welding he has been active in the promotion of education for management men. He has been, since 1944, director of the National Association of Foremen.

Richard W. Sternke

WINSOR JOINS STANDARD OIL

Dr. Frederick J. Winsor recently joined the Engineering Research Dept. of Standard Oil Co. (Indiana), where he will have charge of welding research. He has held positions as research assistant in the Welding Laboratories at Rensselaer Polytechnic Institute and research metallurgist at Armour Research Foundation.

DR. HESS MADE HONORARY MEMBER

Dr. Wendell F. Hess, head of metallurgical engineering at Rensselaer Polytechnic Institute, was made an honorary member of the AMERICAN WELDING SOCIETY at a regular meeting of the directors in New York City on July 16th. The honor was in recognition of his services to the SOCIETY as president in 1945–46, second vice-president the preceding year and chairman at one time or another of the committees on education, awards, honorary memberships and university research. He has held the latter post for 10 years or more. Dr. Hess has also been chairman of the Northern New York section of the society, and second vice-president of the New York-New England district. The award will be made at the annual meeting of the SOCIETY in Philadelphia during the week of October 25th.

MASTER'S AT STEVENS FOR CHARLES EISLER, JR.

Charles Eisler, Jr., vice-president in charge of engineering at the Eisler Engineering Co., Inc., of Newark, received his master's degree in metallurgy at Stevens Institute of Technology in Hoboken at recent commencement exercises.

Eisler, who resides at 16 Hoffman St., Maplewood, N. J., received his degree in mechanical engineering from Stevens in 1938 and in 1940 his degree in electrical engineering at Massachusetts Institute of Technology. He is a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the AMERICAN WELDING SOCIETY.

Eisler's company specializes in the production of glass working equipment, welders and electric transformers.

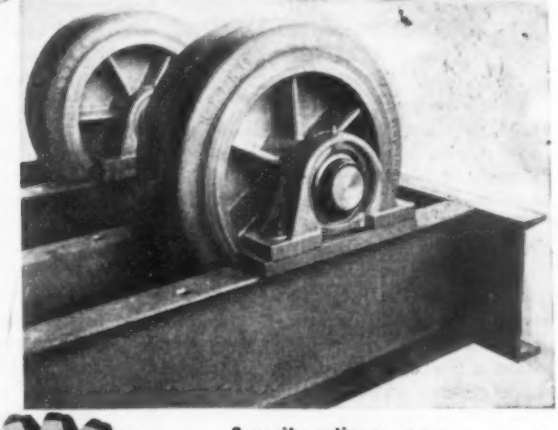
NOW—a new improved line of Ransome TURNING ROLLS

for bigger profits, faster production, better welds

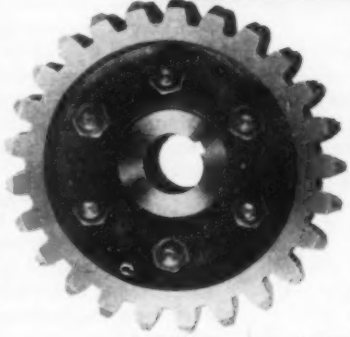
New lowered drive mechanism permits unobstructed loading from either end of rolls.

Anti-friction bearings used where necessary to insure easy rotation under heavy loads.

Bronze-and-steel worm wheel construction for added strength.



Out of Ransome's vast war experience in tank welding has come a new, more efficient line of Ransome Power and Idler Turning Rolls. Three completely new models, A, B and C, offer such profit-building features as: anti-friction bearings, to insure easy rotation under heavy loads . . . a new lowered drive mechanism to permit unobstructed loading from either end of rolls . . . combination steel-and-bronze worm wheel for greater resistance to stresses from heavy loads (a new and exclusive Ransome feature) . . . rubber tired rollers to absorb shock and cushion seams in automatic welding.



Capacity ratings, which are conservative, are as follows: Model A, 4½ tons; Model B, 20 tons; Model, C45 tons.* Information on larger capacity models on request.

For complete details on this new line of Ransome Turning Rolls for Manual or Automatic Welding, mail coupon for special bulletin.

*In each case, with rubber tired rollers.

INDUSTRIAL DIVISION

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MACHINERY COMPANY

DUNELLEN, NEW JERSEY

Subsidiary of

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Industrial Division
Ransome Machinery Company
Dunellen, New Jersey

Please send me, without obligation, the bulletin on the new improved line of Ransome Turning Rolls.

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NEW LITERATURE

SAFETY IN ELECTRIC AND GAS WELDING AND CUTTING OPERATIONS

A.S.A. Sectional Committee Z49 under the sponsorship of the AMERICAN WELDING SOCIETY has just completed a proposed revision to the American War Standard "Safety in Electric and Gas Welding and Cutting Operations," which is being circulated through industry for comments, before approval as an American Standard.

Any member desiring to review a draft copy of the proposed standard should address a request to S. A. Greenberg, Technical Secretary, AMERICAN WELDING SOCIETY, 33 W. 39th St., New York 18, N. Y.

MOLYBDENUM: STEELS, IRONS, ALLOYS

This book by R. S. Archer, J. Z. Briggs and C. M. Loeb, Jr., contains 391 pages, 188 figures and 91 tables plus appendices. It was published in July 1948 by Climax Molybdenum Co.

The varied applications of molybdenum as an alloying element are described in this book, which covers a wide range of materials from wrought to cast steels and from cast iron to nonferrous alloys. The major emphasis has been placed on the presentation of the fundamentals that must guide all engineers, designers and metallurgists in their selection of the most suitable materials for a given application.

In the past, many books have been confined to the presentation of uncorrelated data on specific compositions, each of which has been treated as a self-sufficient entity. Yet, as every practical man knows, many of these are interchangeable within certain limits. In the present book, an attempt has been made to show the fields of similarity and dissimilarity of the various materials and to indicate some of the factors that may affect the choice of the most economical material for a specific part.

The scope of the book is illustrated by the main section headings: Technical Effects of Molydenum, Fundamental Effects of Heat Treatment on Microstructure, Addition of Molybdenum, Wrought Alloy Engineering Steels, Wrought Corrosion Resistant Steels, Wrought Steels for Elevated Temperature Service, Tool Steels, Steel Castings, Cast Iron, Special Purpose and Nonferrous Alloys.

Considerable recent information is included, not only on the more prominent developments, such as the gas turbine steels and alloys, but also on the work that has served to clarify the factors affecting the service life of the lower alloy steels. The references to current literature are adequate to facilitate further reading by anyone who desires more detailed data.

BAUSCH AND LOMB PHOTOMICROGRAPHIC EQUIPMENT, MODEL L

A catalog, descriptive of a new product is now being announced. The Model L is the very "last word" in photomicrographic equipment and news of its availability will be welcome to many readers. Descriptive catalog available on request. Bausch & Lomb Optical Co., Rochester 2, N. Y.

A VISIT TO LUKENS

In connection with its open-house plant visitations which have attracted approximately 10,000 visitors since the summer of 1947, Lukens Steel Co , Coatesville, Pa., has issued a 28-page booklet "A Visit to Lukens," which is given as a souvenir of the occasion at the conclusion of each tour.

The booklet contains a message of welcome from Robert W. Wolcott, president of Lukens, a history of the company since its founding and a description of the various mills, plants and departments which are regularly visited on these tours.

Printed in two colors, and illustrated by photographs of scenes which the visitors may easily recall, the booklet describes the Open Hearth Dept., where the business of steelmaking, in so far as Lukens is concerned, starts; through the 120-in. Mill, which has the most advanced electrical and mechanical equipment for producing substantial quantities of steel plates; the 206-In. Mill, world's largest plate mill; the grinding and trimming shops, and the Flanging Department where heads are spun for tanks, boilers and pressure vessels.

The booklet also describes Lukens Clad Steels Dept. where layers of corrosion-resistant nickel, stainless steel, Inconel or Monel are prepared for bonding by subsequent rolling to backing plates of ordinary steel; and the modern sodium hydride descaling plant, believed to be the largest and most complete of any of its type in the world.

In addition, the booklet gives highlights of Lukens modern Heat-Treating Dept.; the shearing, pressing, bending, blanking and flame-cutting plants of By-Products Steel Co. division, and the two plants of Lukenweld division where weldments, machinery components and completed machinery are fabricated by welding.

A résumé of Lukens employee health and personnel service also is included in the booklet as is a partial list of products and their applications in widely diversified industries. Copies of "A Visit to Lukens" will be sent on request to Lukens Steel Co., Coatesville, Pa.

DATA SHEET ON ELECTRODES FOR WELDING ALLOY CASTINGS

Arcos Corp. now has available a complete technical data sheet on the 11 analyses of alloy electrodes for use in fabrication welding and salvage of both high- and low-alloy castings. Both corrosion-resisting and heat-resisting alloys are included, together with A.C.I. casting designations by type and recommended Arcos electrodes for use with each. Also tabulated are tensile properties and weld metal composition of these Arcos lime and titania types, and hydrogen controlled electrodes.

A copy will be sent upon request to Arcos Corp., 1500 S. 50th St., Philadelphia 43, Pa.

METALS HANDBOOK

Perhaps in no other field of writing and research has there been a comparable volume of scientific data as in the new 1948 edition of *Metals Handbook*, just off the press, and ready for distribution by the American Society for Metals, from the Society's headquarters in Cleveland, Ohio.

The 1948 edition of the *Metals Handbook* contains 1444 pages, and is larger in size than any previous edition prepared by member scientists of the Society. Long accepted as the authoritative source of metallurgical facts, the new edition covers the extended concepts and research which grew out of war production but which, for security reasons, were held in abeyance.

Over 600 engineering and production specialists contributed over one million words on the advance methods of producing thousands of different metal items used in making modern civilization still more modern, still more comfortable and still safer for us all.

The 1948 *Metals Handbook* is divided into four principal sections: (1) General; (2) Ferrous Metals; (3) Nonferrous Metals; (4) Constitution of Alloys.

There are 74 articles on metals, processes and methods in the general section. Among these are included new summaries of wear, oxidation, stress corrosion, relief of residual stress and service failures. One hundred thirty-one authoritative articles cover ferrous metals, from the manufacture of iron and steel, through shaping, testing, structural properties, welding, heat treating and finishing, to the practical business of hardening, coating and surface treatment.

There are 102 articles and 220 data sheets about nonferrous metals, including for the first time, discussions of melting, shaping, treating and corrosion. The new 1948 edition of *Metals Handbook* also contains a new section on the eight precious metals.

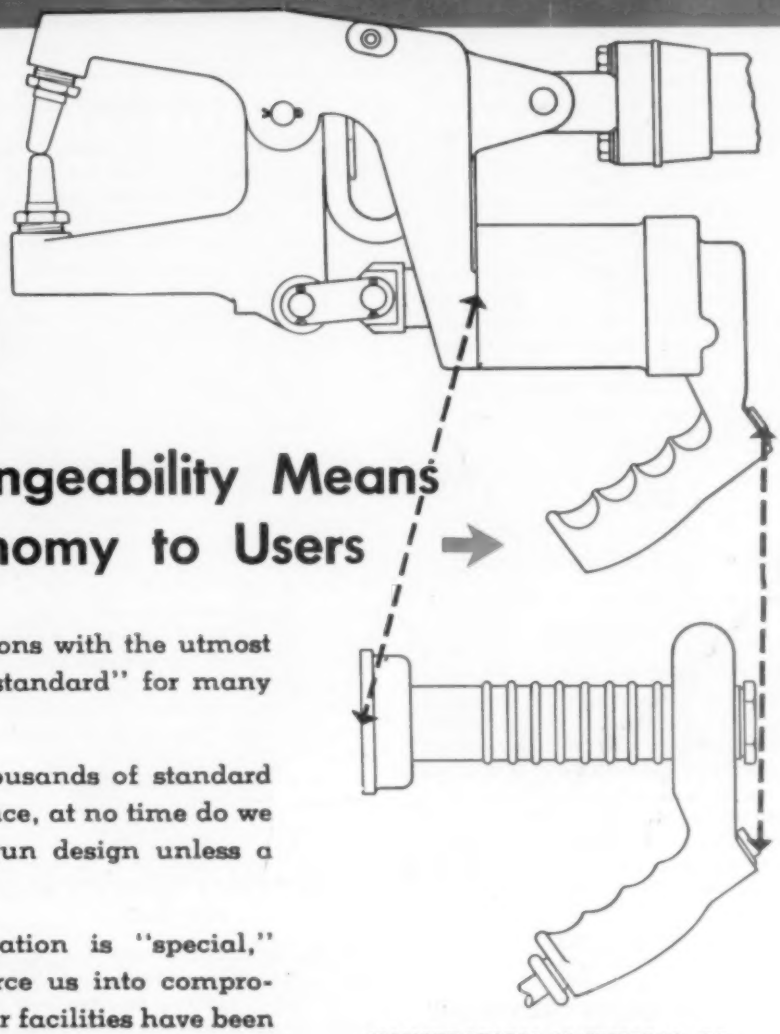
The first extensive collection of alloy phase diagrams ever published in America is presented in the Constitution of Alloys section.

The 1948 edition of *Metals Handbook* (American Society for Metals, Cleveland, price $15) can be obtained by writing the American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.

·MARTIN· WELDING GUNS

SPECIALIZED FOR THE SPECIFIC JOB!

A Sensible Degree of Standardization and Parts Interchangeability Means Efficiency and Economy to Users



Analyzing welding gun applications with the utmost of care has been a Martin "standard" for many years.

Although we have compiled thousands of standard gun designs in 21 years of experience, at no time do we attempt the use of an existing gun design unless a "perfect fit" is assured.

Since practically every application is "special," standardization would merely force us into compromises in design. For this reason our facilities have been organized with the view of designing and building low cost, tailor-made guns for the specific welding job.

All Martin welding guns are equipped with standard interchangeable type cylinder and handle assemblies. Either air or hydraulic type cylinder assembly of various bore and stroke combinations are applicable to each handle.

ILLUSTRATION IS TYPICAL OF INTERCHANGEABILITY PRINCIPLE

Shown herewith is a typical Martin gun where air cylinder and hydraulic cylinder are interchangeable. Any type Martin cylinder assembly can be supplied with a choice in handle designs. All Martin guns have the desirable rolling shunt feature so conducive to ease of handling.

This Martin catalog shows some 500 gun designs—ample proof that *only* through specialized design can specific welding job requirements be met fully. Consult Martin on your requirements.

·MARTIN·

ELECTRIC COMPANY

3040 EAST OUTER DRIVE • DETROIT 12, MICHIGAN

AMERICAN ARC WELDING PATENTS

Edited by W. H. Simon, Ph.D., the welding patent expert, with a foreword by Wendell F. Hess, Professor of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. Patents added up to Jan. 1, 1948. Published by McAinsh & Co., Ltd., 388 Yonge St., Toronto, Canada. The preparation of this survey has necessitated research involving welding patents of no less than 65 classes and 250 subclasses, an undertaking too costly, if not impossible, for the average inventor or patent serviceman.

The subject matter of this work is electric arc welding. However, many gas welding material patents, especially on welding rods, alloys and also various gas welding applications apply to both processes; the latter are therefore included in this volume except those on equipment.

A supplement is available, without charge, to those who have already purchased the first edition. The new edition is priced at $22.60 which is a reduction from the original price of $40.

VEST POCKET WELDERS' GUIDE

A new booklet to "fit the pocket," is filled with useful welding information. Among other things, it gives the characteristics of various welding arcs, 4 essentials of proper welding procedures, type of joints, typical positions, chart of standard steel shapes, photographs of good and bad welds, causes of common welding troubles and what to do about them, welding symbols and an easy-to-use table of "How to Find" formulas. A copy will be mailed free of charge on request to the publisher, Hobart Brothers Co., Troy, Ohio.

GUIDE TO ACCIDENT PREVENTION

A new catalog just released by the Chicago Eye Shield Co. not only lists the company's products but also tells where to use, how to use, how to maintain and how to select industrial protective equipment. By going well beyond the scope of an ordinary catalog it becomes a guide to accident prevention.

Among the 64 pages in the book are 16 pages explaining correct safety procedures. For example, a spread on spectacle-type goggles gives applications and uses of spectacles, what features to look for in good goggles, how to fit spectacle-type goggles, proper care of goggles, and construction details of Cesco products. Pages like these also give complete buying data on cup goggles, welding goggles, welding helmets, face shields, respirators, masks, hoods and protective aprons and sleeves.

Facts presented on these technical pages are based on official reports and recommendations, and much of the information applies to all protective equipment, regardless of make.

A copy of this 64-page Cesco catalog can be obtained by writing the Chicago Eye Shield Co., 2300 Warren Blvd., Chicago 12, Ill.

NATIONAL WELD TIMERS

The National Time & Signal Corp., 21800 Wyoming Ave., Detroit 20, Mich., has just issued an attractive four-page brochure, Bulletin No. 170, which is available upon request. This bulletin describes the weld timers applicable to the various types of resistance welders.

RAPIDESIGN

Rapidesign, Inc., announces a new 4-page catalog covering the company's Time-Saver Templates for engineers, designers, draftsmen and architects. Each type of template, including welding, is pictured, designated by number and briefly described. A copy may be obtained by writing to Rapidesign, Inc., P. O. Box 592, Glendale, Calif.

AMPCO CONDENSED CATALOG

A condensed catalog called Bulletin 95 has been issued by Ampco Metal, Inc., Milwaukee, Wis., producers of Ampco Metal and bronze products. This 16-page bulletin covers the Ampco line and gives information on a wide range of bronze products and alloys.

Besides various alloys the product range covers bronze rod and sheet, nonsparking Safety Tools, resistance and arc welding electrodes, corrosion-resistant centrifugal pumps, plug valves and fabricated assemblies.

Copies of Bulletin 95 will be sent on request.

ELECTRONICS REFERENCE BOOK PUBLISHED

A reference book to help electrical engineers understand and apply new electronic equipment in industry has just been published by John Wiley & Sons, New York City.

Prepared by electronics and research engineers of the Westinghouse Electric Corp., the 680-page *Industrial Electronics Reference Book* contains 36 chapters on the basic theory of electrons and the design, application and maintenance of electronic equipment in industry. This handbook includes within one cover all the technical data needed to understand the scope and limitations of electronic equipment as used in industry. It will be useful to engineers faced with the problems of approving or rejecting industrial electronic equipment.

The many different types of industrial equipment—including powerline carrier equipment, power rectifiers and inverters, radio frequency heating and electronic instruments—are presented with their advantages and limitations for industrial use in Chapters 21 through 34.

The two final chapters outline the factors involved in the care and maintenance of electronic tubes and apparatus.

The *Industrial Electronics Reference Book*, measuring 9 by 11 in., can be obtained from John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. Its price is $7.50.

TRADE ASSOCIATION RESEARCH

How trade associations and other groups of manufacturers carry on their technical and scientific research in industry-wide problems is the subject of a study published recently by the Department of Commerce.

The Department had the assistance of 80 cooperating associations in gathering and preparing the material for publication, according to H. B. McCoy, Director of the Office of Domestic Commerce. Text is the work of Gustav E. Larson, of ODC's Trade Association Division.

The 64-page booklet, "Trade Association Industrial Research," describes how associations finance research; select technical committees and decide on projects; coordinate and supervise research programs; and disseminate findings in their industries. It should be of particular value to trade association executives who wish information on industrial research management practices, or are looking for suggestions for further research programs in their own industries, and in obtaining support for them.

Copies of "Trade Association Industrial Research" may be obtained through the field offices of the Department of Commerce, or from the Superintendent of Documents, Washington 25, D. C., at 25 cents each.

NEW ELECTRODE AND PREHEAT CHART

Recommended arc-welding electrodes for joining like or dissimilar metals are charted in Bulletin W-19, just published by Ampco Metal, Inc., Milwaukee 4, Wis. The new chart lists 31 alloys and shows which of five bronze electrodes is best suited for the welding application together with proper preheat for each joining application.

The metals listed cover copper, copper-base and iron-base alloys. The trademarked electrodes selected for joining these metals include Ampco-Trode 10, Ampco-Trode 160, Phos-Trode, Sil-Trode and Beryl-Trode.

This is one of the most useful charts on welding dissimilar metals ever offered to the welding industry. Copies may be obtained without charge on application to Ampco Metal, Inc., or any of their authorized welding distributors.

RESPIRATORS

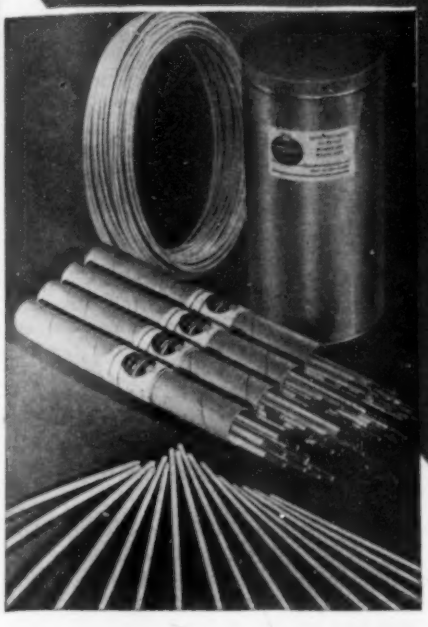
A new chart suggesting the proper respiratory protection against more than 150 specific dusts, vapors and gases has been published by American Optical Co. Free copies can be obtained by writing the company direct at Southbridge, Mass.

The chart presents a summary of recommendations made by the Safety Engineering Division of American Optical Co. for the use of the company's R-1000, R-2000 and R-9100 respirators, all three of which have been approved by the U. S. Bureau of Mines.

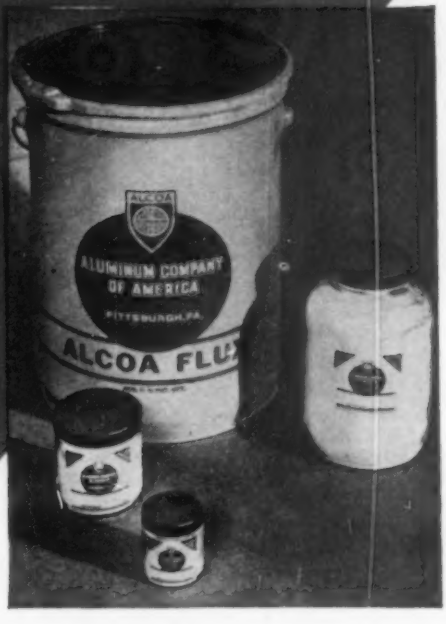
The respiratory hazards are listed alphabetically in the chart with the proper protection clearly and easily identifiable.

(*Continued on page 666*)

STOCKS OF ALCOA ALUMINUM WELDING AND BRAZING RODS AND FLUX ALMOST AT YOUR ELBOW



When you need the best rods and flux for welding and brazing aluminum, telephone your nearby Alcoa Distributor at the number listed below. He is organized to give you immediate service on Alcoa Aluminum Rods and Flux. He also carries Alcoa Aluminum in its commercial forms. You'll find him a good man to know.



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Baltimore, Maryland
Whitehead Metal Products Co., Inc.
Phone: LAfayette 2300

Boston (Cambridge) Massachusetts
Whitehead Metal Products Co., Inc.
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- Brace-Mueller-Huntley, Inc.
Phone: RIverside 2620
- Whitehead Metal Products Co., Inc.
Phone: CLeveland 1475

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Edgcomb Steel Company
Phone: 4-9768

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- Central Steel & Wire Company
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Phone: PRospect 0171

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Brace-Mueller-Huntley, Inc.
Phone: GLenwood 0962

San Francisco, California
Pacific Metals Co., Ltd.
Phones: MIssion 7-1104
ENterprise 1-0806

Seattle, Washington
Pacific Metal Company
Phone: MAin 6925

St. Louis, Missouri
Metal Goods Corporation
Phone: GOodfellow 1234

Syracuse, New York
- Brace-Mueller-Huntley, Inc.
Phones: SYracuse 4-4171 3-9151
- Whitehead Metal Products Co., Inc.
Phone: SYracuse 5-4112

Toledo, Ohio
Williams & Company, Inc.
Phone: ADams 8102

Tulsa, Oklahoma
Metal Goods Corporation
Phone: 4-1175

ALCOA FIRST IN ALUMINUM

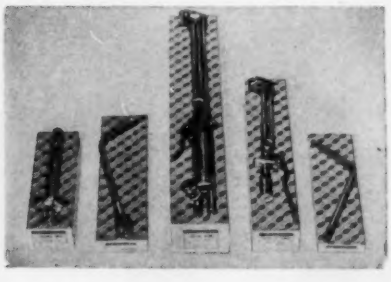
ALCOA ALUMINUM 1888 1948 60 YEARS OF SERVICE

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this section

NEW PACKAGING TO IDENTIFY AIR REDUCTION PRODUCTS

The Air Reduction Sales Co. has announced the adoption of a colorful new set of boxes and cartons for packaging of their welding torches, tips, cutting attachments, regulators and other products.



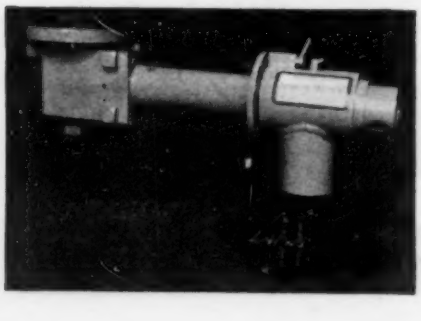
The purpose of the new orange and black containers is to afford greater protection to its line of high quality products; permit better dealer stock control, quicker inventory taking and easier handling.

Each product is packaged in an individual box, clearly marked by product name and stock number. This information appears on one end of the box which permits easy identification.

Already being used on most Airco products, this new packaging arrangement will be expanded to include all Air Reduction products which lend themselves to individual boxes or cartons.

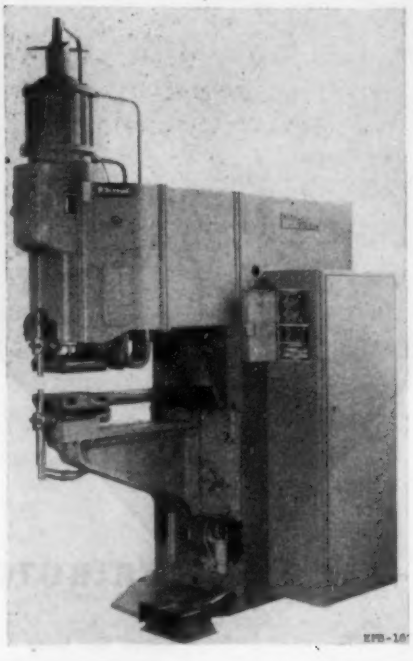
BENCH POSITIONER

The Aronson Machine Co., Arcade, N. Y., has issued a circular describing their new Aronson Universal Bench Positioner. This positioner may be mounted on a work bench for small production work allowing a complete rotation about 3 axes, work table rotation 360°, head rotation 360° and pedestal rotation 360° with positive locking on all three. The 6-in. diameter work table revolves on roller bearings.



THREE-PHASE WELDING

Under today's conditions, power supply for resistance welding has become an increasingly important consideration. After extensive development Taylor-Winfield is now in production on Tri-Phase welders to help overcome power supply difficulties.



Tri-Phase, with three-phase balanced power, gives a desirable high power factor (95%) at greatly reduced power demand.

Tri-Phase in correcting power supply difficulties, has attained advantages that are very desirable in resistance welding. More production or heavier welding is possible with present power installations. Improved quality of welds can be obtained with Tri-Phase.

Welding schedules are easier to obtain and maintain. Reduced electrode wear and pickup are evident with Tri-Phase. Closer spot spacing and less sensitivity to work thicknesses are additional advantages.

The Tri-Phase welding circuit permits a greater range of shapes and sizes of work to be welded, especially in deep-throated welders. Tri-Phase gives increased production as to quantity as well as variety of welded products within the range of the welder, with improved quality. Welding currents are essentially constant when magnetic work or fixtures are moved into work area. The same applies when work clearances vary.

Maintenance is reduced to a minimum. The Tri-Phase may be had in spot, seam, projection and upset-butt welders. The "production-proved" features of Taylor-Winfield welders have been retained in the Tri-Phase models.

A "NEW LOOK" IN ELECTRODE PACKAGING

The Champion Rivet Co. have recently adopted two redesigned packages for their welding electrodes. The fiber board carton is of the double-folded inner liner type with a layer of asphaltic paper to protect the electrodes from excessive moisture pickup.

The metal can package is lithographed on all sides employing a "school bus" yellow background with bright red lettering. This type of package will be used for shipping their electrodes into territories where the humidity conditions are excessive—also for export.

BARE BRONZE WIRE FOR SUBMERGED-ARC WELDING

Users of the submerged-arc process of welding can now obtain a newly developed bronze bare wire in coils that is entirely satisfactory for overlaying large steel areas for bearing, wear- and corrosion-resistant service or for joining aluminum bronze.

The new wire is called Ampco-Trode 10 bare wire and is produced by Ampco Metal, Inc., Milwaukee 4, Wis., for use in steel mills, railroad shops, etc., where it is more economical to apply deposits of this grade of Ampco-Trode over large areas by an automatic process in preference to hand welding.

Dense, uniform deposits free from cracking are obtained through the use of this wire.

Additional technical information, recommended melts, physicals, etc., may be obtained on request from Ampco Metal, Inc., Milwaukee 4, Wis.

FLUX COATING OF WELDING RODS IMPROVED

The manufacture of flux-coated welding rods by Eutectic Welding Alloys Corp. has been improved chemically and metallurgically by allowing for a greater and thinner flow of the joining alloy. This rapid flow insures capillary action, smoother welds, protects the weld area from overheating and minimizes the possibilities of distortion and stress to the parent metal.

The improved capillary flow of flux-coated welding rods eliminates delays due to manual fluxing operations and reduces the amount of heat ordinarily applied to the area. This reduced heat leads to the welds that are warp-free, scale-free, and the surfaces then are

IT'S *Sureweld* FOR SURE, BETTER WELDS!

North, South, East, West—in big industries and small—Sureweld Electrodes are helping welders get the job done faster, better, easier. New users are discovering every day what thousands of old users have known for years—that Sureweld can be depended on for top performance—whatever the welding problem.

Prove it for yourself! Call in an NCG representative or distributor and let him recommend a rod for the job that's giving you the most headaches. You'll soon learn for yourself that Sureweld excels in speed, easy operation, easy slag removal, low spatter loss and excellent bead appearance. You'll cheer Sureweld's uniformly high quality.

NCG

EVERYTHING FOR WELDING

NCG is recognized as one of the largest organizations of its kind in the world. It operates 73 manufacturing plants within the United States, offers supply and service by a vast network of hundreds of independent NCG distributors and warehouses. For assured satisfaction in your welding and cutting needs . . .

RELY ON NCG

"We have used Sureweld Electrodes exclusively for the past six years, and the marked preference of our foremen and welders for Sureweld makes it quite evident that we shall continue to use them 100% in the future," says Jack Frost, vice-president of Wiley Manufacturing Company, Mountville, Pa., manufacturers of floating cranes, steel barges, Wiley Whirleys, concrete buckets and fabricated steel.

"Our choice has always been Sureweld," says L. E. Heldenbrand, President, Heldenbrand & Son Manufacturing Company, Oklahoma City, Okla., manufacturer of "Silver King" products. Sureweld is used in the production of the 4-in-1 Silver King Cattle Chute, requiring 200 welds per finished unit. "Sureweld N fits our need because it is fast, gives good penetration and welds in all positions," says Mr. Heldenbrand.

"We like the clean, even beads deposited by Sureweld B—we think it is the smoothest-running wire we have ever used," says F. E. Collier, owner of Charlotte Ornamental Iron Works, Charlotte, N.C., fabricators of "Trustube". "We have used NCG services and supplies since we first started in business, and we like the prompt, friendly attention we always get," states Mr. Collier.

NATIONAL CYLINDER GAS COMPANY

Executive Offices: 840 N. Michigan Ave., Chicago 11, Ill.

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adequately fluxed to insure surface alloying that actually improves the physical properties of the joints welded.

IPCO WELDING CURTAINS

Designed to confine the welding operation to a given area and protect other workers and passers-by from the harmful direct and reflected rays given off by the welding operation; these curtains also serve as a protecting shield against flying chips and scale when cleaning is being performed. Constructed of a special flameproof and waterproof canvas, or asbestos, a double row stitching is used on all seams; substantial hem on all four sides; corners reinforced. The workmanship is thorough.

Standard curtains are furnished with eyelets across the top spaced approximately 10 in. apart and with two in each lower corner. They may be suspended on a horizontal rod or pipe support by means of hooks or cord laces, and bottom eyelets allow for rope attachment to pull curtain taut. This provides an easy means of pulling curtain out of the way when space is to be cleared or for taking work in or out.

A close woven canvas specially treated to make it both flameproof and waterproof. Being of a dull dark color it helps to absorb the welding rays rather than reflect them. Made of high quality, close woven asbestos cloth, Navy grade—a strong cloth that has proved very practical for welding curtain construction.

Manufactured by Industrial Products Co., 2820 N. Fourth St., Philadelphia, Pa.

SAFETY GOGGLE

A new head-rest safety goggle which offers exceptional comfort, convenience and protection for gas welders, burners, cutters, brazers and furnace men is announced by American Optical Co., Southbridge, Mass.

Based on an entirely new spring mechanism, the new goggle can be instantly thrown into "off-guard" position by a mere flick of the wrist. The goggle is perfectly balanced—and because of the spring mechanism there is no overhanging weight, even when the goggle is in the "off-guard" position.

Adjustment to facial contours and correct pupillary distances can be made instantaneously—without tools—and once the adjustment is made for any face, no readjustment is necessary, regardless of how often the goggle is used.

The Duraweld Coverglas goggle that comes with the new development protects

eyes against injurious light radiations, glare, flying sparks and scale. It may be worn directly over the eyes or personal prescription glasses.

The fiber headgear fits comfortably and is adjusted to any head size by a nut turning on a right- and left-hand threaded stud. Genuine leather sweatband provides additional comfort.

NEW FATIGUE TESTING MACHINE

Growing demand and need for testing equipment that is capable of loading full-sized machine and structural parts or assemblies under simulated service conditions are being met by the development of larger testing machines. In the field of fatigue testing where there is a wide variety of requirements, some structural elements are subjected to continued high-frequency vibrations of low amplitude. On the other extreme, there are parts such as springs that are normally subjected to low-frequency vibrations or stress variations with high amplitude.

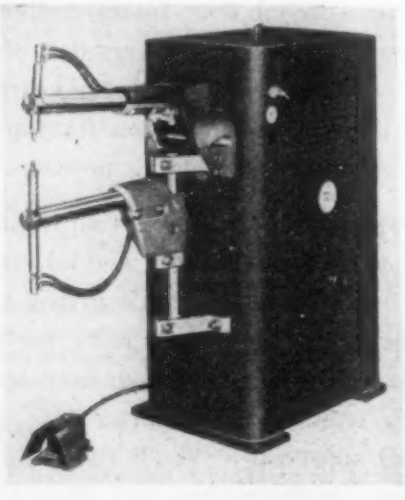
To meet requirements of the latter type The Baldwin Locomotive Works, Testing Equipment Division, has developed a line of fatigue testing machines on which the stroke can be varied from 0 to 8 in. Loads up to 10,000 lb. can be applied directly in tension and compression and with simple fixtures torsional fatigue loading can be applied.

A new Universal Fatigue Testing Machine of the constant force stroking type, Model BF-10-U, is shown.

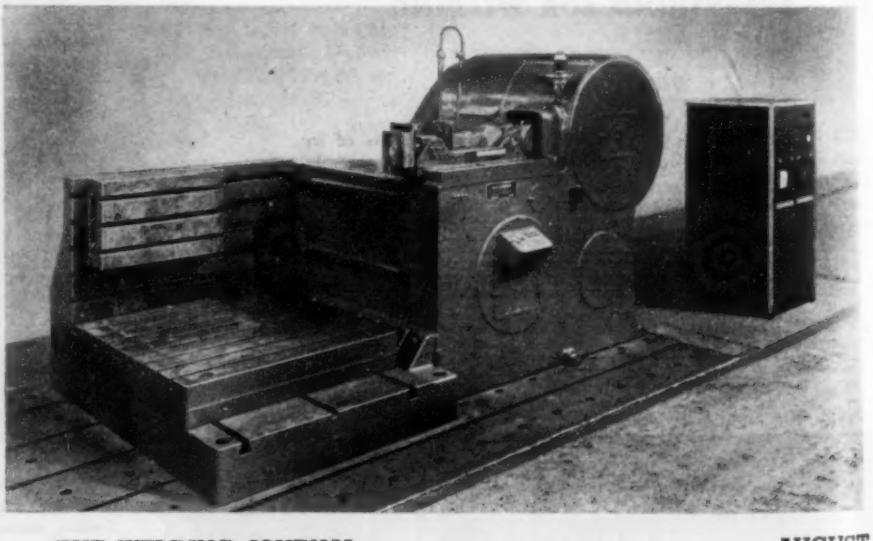
It is a flexible, crank-stroking type in which the stroke is adjusted by a planetary gear system with an independent motor that maintains constant load by varying automatically the distance of a spindle from the center of rotation. The spindle serves as a crank in activating the connecting rod and crosshead that applies fatigue stress to the part under test. Large parts and assemblies up to approximately 5 x 5 x 5 ft. can be subjected to fatigue loading in this machine.

STANDARD ROCKER ARM WELDERS

A new and improved line of standard air-operated rocker arm welders, in both 30- and 50-kva. capacities and with throat depths ranging from 18 to 36 in. for each capacity, has been announced by Progressive Welder Co., 3050 E. Outer Dr., Detroit 12, Mich.



In general construction, the new rocker Arm welders follow the structural principles recently incorporated in the latest Progressive pedestal- and press-type welders. The front part of the machine which carries the welding stresses is of heavy reinforced welded steel construction, giving strength where strength is needed. The rear part of the machine serves mainly as an enclosure and is provided with quick removable panels to give complete access to the entire interior of the welder.



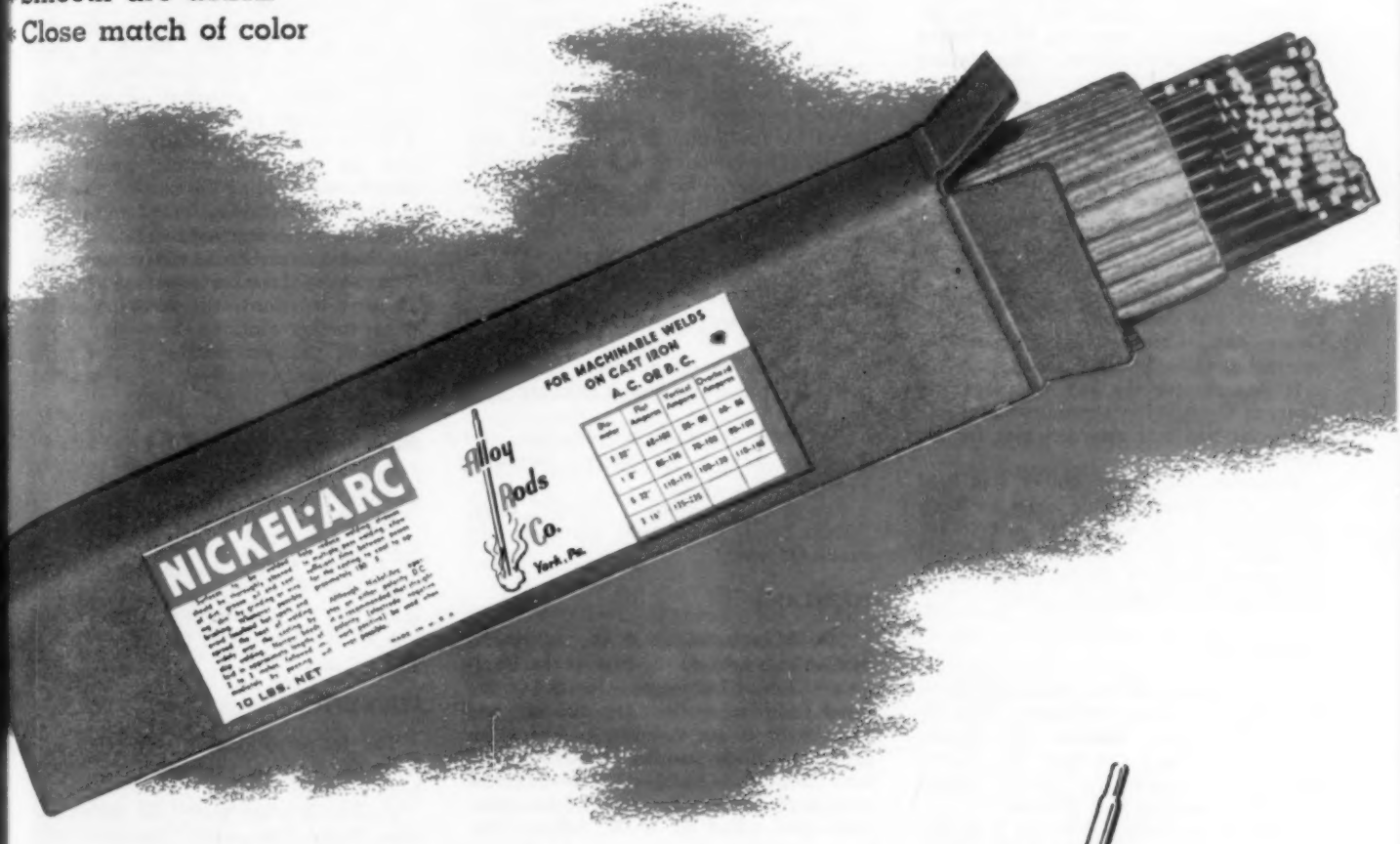
Still AMERICA'S FAVORITE for WELDING CAST IRON

NICKEL-ARC

gives you

- Easily machinable welds
- Porosity-free welds
- Crack-free multipass welds
- Smooth arc action
- Close match of color

Thanks to these advantages, NICKEL-ARC repairs of cracks, weaknesses and defects in iron castings are saving thousands of dollars every year in plants all over the country. That's why NICKEL-ARC is America's number one electrode—for fast, efficient cast iron welding with AC or DC current.



A COMPLETE LINE OF QUALITY ELECTRODES

ARCALOY
Stainless Steel

WELD-ARC
Mild Steel
Low Alloy-High Tensile Steel
Low Hydrogen

TOOL-ARC
Tool Steel

WEAR-ARC
Hard Surfacing

CUPRO-ARC
Phosphor Bronze

Alloy Rods Co.
York, Pa.

Look for the ***FLAMING-ARC*** *trademark*

SECTION ACTIVITIES

CHICAGO

Some 292 members and guests of the AMERICAN WELDING SOCIETY'S Chicago district weathered a cold, damp, windy day in order to participate in the section's seventh annual Golf Tournament, June 9th, at Gleneagles Country Club. In payment for their efforts about 83 prizes were awarded to the best and the worst scores turned in at the starter's table.

Blind bogey was the system employed and the fellows decided their own fate when choosing their handicap. After all golfers had returned their scores, the Rules Committee drew the blind bogey number between 76 and 94. The winning number was 84.

First prize winner with a gross of 77 was Victor Straz of Pettibone Mulliken Corp. He received the district A.W.S. cup, to be returned next year, and a selection of one of the prizes.

Ken Ziegler of National Cylinder Gas Co., whose score of 91 minus his chosen handicap of 7, was awarded next choice of the many prizes. Low net golfer with a par of 72 was Charles W. Steele of Steele Gases, Inc., Chicago. He received for his work the Charles Bastian cup.

High gross for the day was Metal & Thermit Corp.'s Joe Desano with a 135. A special cup was awarded him for his sincere efforts.

Following the game, dinner was held in the club's main dining room for both golfers and those who came just to see the gang. Total attendance numbered 350 and the majority left for home looking forward to the occasion next year.

CLEVELAND

The following officers were elected to serve for the fiscal year beginning May 14, 1948: *Chairman*, Michael S. Shane; *1st Vice-Chairman*, Arthur G. Portz; *2nd Vice-Chairman*, J. Calvin Wyss; *Secretary-Treasurer*, J. F. Wagner.

Executive Committee: Edward T. Scott, J. Franlin Maine, Robert Kriz, Ross Yarrow, John R. Morrill, C. Tom Elder, A. Leslie Pfeil, Michael S. Shane, Arthur G. Portz, J. Calvin Wyss, J. F. Wagner, Kent C. Thornton.

COLORADO

The following officers have been elected to serve for the fiscal year beginning July 1, 1948:

Chairman, H. Jaekson; *1st Vice-Chairman*, Jas. A. Hynds; *Secretary-Treasurer*, C. Brinton Swift.

Executive Committee: J. H. Johnson, G. H. Garrett, Edmund J. Berens, Maurice Eddy, Howard K. Schmuck, J. L. Fry, Herbert B. Klodt.

Chairman, Membership Committee, Howard K. Schmuck.

These men were elected to serve at the regular meeting of the Colorado Section held on April 13th.

INDIANA

The final meeting of the year of the Indiana Section of the AMERICAN WELDING SOCIETY was held on Friday, May 21st at the J. D. Adams Mfg. Co. in Indianapolis. A buffet dinner was served to 94 members and guests at 6:30 P.M. followed by a plant tour. After seeing the welding and many other operations, the group returned for a panel discussion. The panel consisted of J. D. Adams, design engineer, metallurgist, production welding foreman, welding inspector and welding engineer. Several questions were asked by the group and were very ably answered by various members of the panel.

Officers elected for the coming year are: *Chairman*, R. F. Smith; *1st Vice-Chairman*, Karl Kick; *2nd Vice-Chairman*, Robert Sharpe; *Secretary*, Mrs. Mercedes Spotts; *Treasurer*, Paul Grubbs.

MAHONING VALLEY

The following officers were elected to serve for the fiscal year beginning July 1st:

Chairman, J. Carroll Jennings; *1st Vice-Chairman*, I. A. Oehler; *Secretary-Treasurer*, J. J. Riley.

Executive Committee: George Fogg, Wilson Scott, Art Waldo, Harry Lyons, Frank Q. Jones.

MARYLAND

The May meeting of the Maryland Section was held on the 21st at the Engineers' Club of Baltimore. Instead of the usual technical session, the meeting was given over to an audience participation program. Each member of the audience was assigned a number. The numbers were drawn from a hat and the questions were then asked by E. B. Lutes. The time score was kept by E. A. Brown. The judges were C. N. Hilbinger, J. H. Humberstone and B. Ronay. The prizes (ball point pens) were given to members of the audience who answered a set of three questions correctly. A choice could be made of the subject.

The following officers will serve for the 1948–49 season:

Chairman, G. E. Linnert; *Vice-Chairman*, E. A. Brown; *Secretary*, E. B. Lutes; *Treasurer*, L. C. Ragland.

Chairman, Program Committee, E. A. Brown.

Chairman, Membership Committee, F. Albrecht.

MILWAUKEE

The eleventh annual spring party of the Milwaukee Section was held in the Elks Club Building in Milwaukee on Saturday, May 22nd. There were about 140 couples present to enjoy the festivities.

Announcement of the election of the following officers was made:

Chairman, C. C. Hart; *Vice-Chairman*, L. E. Grant; *Secretary-Treasurer*, E. P. Walbridge.

Directors: G. W. Leupold, F. G. Flocke, D. E. Wilson. Other directors who will serve with the new officers are: N. E. Bailie, F. E. Garriott, Werner Gallo and Paul Alexandroff.

The past-chairman's pin was presented to Mr. Bailie by Jerry Welch, a former chairman of the Milwaukee Section.

An excellent program of entertainment was then presented, which included a clever and talented lady ventriloquist and an attractive young woman who abandoned welding in one of the local plants for entertaining on roller skates.

Dancing was enjoyed to a late hour and concluded a satisfactory evening for all. The success of the party and especially the pleasure it affords the feminine participants further confirms the advisability of devoting the last meeting of the spring season almost exclusively to social activities.

NORTHERN NEW YORK

The following officers were elected to serve for the coming year:

Chairman, C. M. Rhoades, Jr.; *1st Vice-Chairman*, R. A. Wyant; *2nd Vice-Chairman*, J. P. Frandsen; *Secretary-Treasurer*, A. G. Craig. *Executive Committee*, H. D. Westendarp, Jr., H. L. Palmer, G. W. Garman, E. G. Forgette, E. N. Boswell and R. L. Browne.

ROCHESTER

The following officers were elected to serve for the fiscal year beginning Friday, May 7, 1948:

Chairman, Fred Hall; *1st Vice-Chairman*, Walter Kazoroski; *Secretary-Treasurer*, Walter G. Dick.

Executive Committee: Robert Cattanach, William Conley, Paul Ecklund, Herbert Fetter, Robert Jackson, Gordon Kane, Harry Stoler, Edward Jones.

SOUTH TEXAS

The June meeting of the Section was held on the 25th at the Post 52 American Legion Hall in Houston. There was an attendance of 76. The business meeting was preceded by a one-hour floor show which proved to be very entertaining. The retiring chairman was presented with a past-chairman pin, and announcement was made that a similar presentation will be made to former chairman T. J. Kegg. New members were introduced and welcomed by the assembly.

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 10, D. C.

2,442,017—Welding Control System—Robert W. Price, Murrysville, Pa., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

Thjs patented system relates to arc welding wherein means for supplying a nonconductive flux to the zone between the electrode and the work are provided. The welding circuit includes an electrode-controlled valve for regulating the aforesaid means, which is energized in accordance with the voltage of the welding system to render the valve nonconductive when the voltage of the welding system is at open circuit value, to permit striking the arc without interference from the flux.

2,442,029—Electrode Holder—Russel A. Welch, Detroit, Mich.

This novel electrode holder has an apertured tubular handle which has electrode positioning means adjustably received within the handle bore.

2,442,087—Welding Rod—Edward M. Kennedy, Los Angeles, Calif., assignor to Mills Alloys, Inc., a corporation of Delaware.

Kennedy's welding rod includes a longitudinally split tube that has a welding mixture received therein and with a longitudinally directed weld form in the tube to retain the weld mixture therein. In its manufacture the tube is subjected to an axially progressive peripheral pressure which compresses the tube and contracts the weld mixture, after which the ends of the tube are closed.

2,442,423—Wire Welding Tool—Malcomb V. Lomax, Brooklyn, N. Y., assignor to Control Instrument Co., Inc., a corporation of New York.

This welding tool has cooperative movable members having jaws thereon for gripping the extremities of wires. An electrode is mounted on one member for movement toward the other member and establishing contact between wires carried thereby. One of the jaws is movable transversely of the movement of the electrode.

2,442,426—Apparatus for Welding Gear Wheels—Irving R. Metcalf, Chicago, Ill., assignor to Whiting Corp., Harvey, Ill., a corporation of Illinois.

This welding apparatus supports a body thereon and a movable electrode is provided with means for holding a tooth thereon. Other means shift the electrode to move the tooth thereon into position for welding the tooth to the body. A second electrode is adapted to contact the body and means for passing current through the electrode, tooth and body for welding the tooth on the body are also provided.

2,442,448-2,442,449—Electric Welding Tool—Robert F. Zimmerman, Cincinnati, Ohio, assignor to Lathrop-Hoge Construction Co., Cincinnati, Ohio, a Partnership.

Zimmerman's welding tool has a rotary-driven member for engaging with an electrode adapted to apply resistance welding pressure to the work. A torque release clutch for driving the rotary-driven member, and means controlled by the rotary-driven member for applying welding current when the resistance to movement of the electrode has built up sufficiently to release the torque release clutch are also associated with the apparatus.

The second patent covers a somewhat similar tool for arc welding operations wherein the electrode is thrust into the work to be welded thereto and the welding current is simultaneously disconnected as the electrode is thrust into the work.

2,442,505—Constant Speed Burning Attachment for Hand Torches—Harvey U. Millett, Hawthorne, Calif.

This patent covers a centrifugal speed governing device mounted upon a wheel-supported frame that positions an acetylene torch for movement adjacent to the work.

2,442,798—Spot Welder Tip—Ernest Crabtree, Toronto, Ontario, Canada.

The patented spot-welder tip includes a tip-forming member which is externally threaded adjacent the outer end thereof and has a nut screwed thereon for bearing against the end portion of the holder in which the tip is received in order to exert a releasing pull on the tip when same is to be released.

2,442,832—Starting Device for Arc Welding Machines—Joseph M. Tyrner, New York, N. Y., assignor to Air Reduction Co., Inc., a Corporation of New York.

The device of this patent has a movable welding support provided with means for feeding an electrode toward the work. The support is normally urged in a direction away from the work and a welding current conductor is associated with the apparatus and has an iron core surrounding the conductor and connected to the movable support. The core has a pivoted section which may be latched into its extended position but it also can be pulled into position adjacent the conductor to release the support for rapid movement of same and an electrode carried thereby away from the work when welding current flows through the conductor.

2,442,892—Welding Fluxes—George W. Harvey, San Diego, Calif., assignor to Solar Aircraft Co., San Diego, Calif., a corporation of California.

This welding flux comprizes a paint for coating rich ferrous alloys prior to welding them. The paint includes, in anhydrous form, a mechanical mixture of titanium dioxide, boron oxide and a metal silicate.

2,442,043—Electrode Holder—Clifford Laskey, Berkeley, Calif.

Laskey's electrode holder includes a trigger sleeve in the holder device and spring means associated with same for urging an electrode engaging member longitudinally of the holder.

2,443,052—Ejector Type Electrode Holder—Henry A. Mullen, Milwaukee, Wis., assignor to Ampco Metal, Inc., Milwaukee, Wis., a corporation of Wisconsin.

This special holder has a barrel body adapted to receive and hold the electrode tip at one end thereof and a movable head is provided at the opposite end for supplying cooling fluid to the body. The movable head also applies ejector forces to means extending longitudinally of the body for ejecting the electrode tip. A fluid tight seal is provided between the body and head of the holder and includes a cylindrical bellows extending therebetween adapted to flex to permit ejector movement of the head.

2,443,077—Welding Machine—William H. Martin, Detroit, Mich., assignor to Martin Electric Co., Detroit, Mich., a corporation of Michigan.

This patent relates to a welding machine which has a plurality of tipped electrodes, that has a multiple secondary transformer provided with a plurality of secondaries, the number of which is equal to the number of electrodes and is paired therewith. The patent covers a special control for the welding machine.

2,443,467—Electrode Holder—Donald Lloyd, Oklahoma City, Okla., assignor of one-half to Albert C. Fletcher, Oklahoma City, Okla.

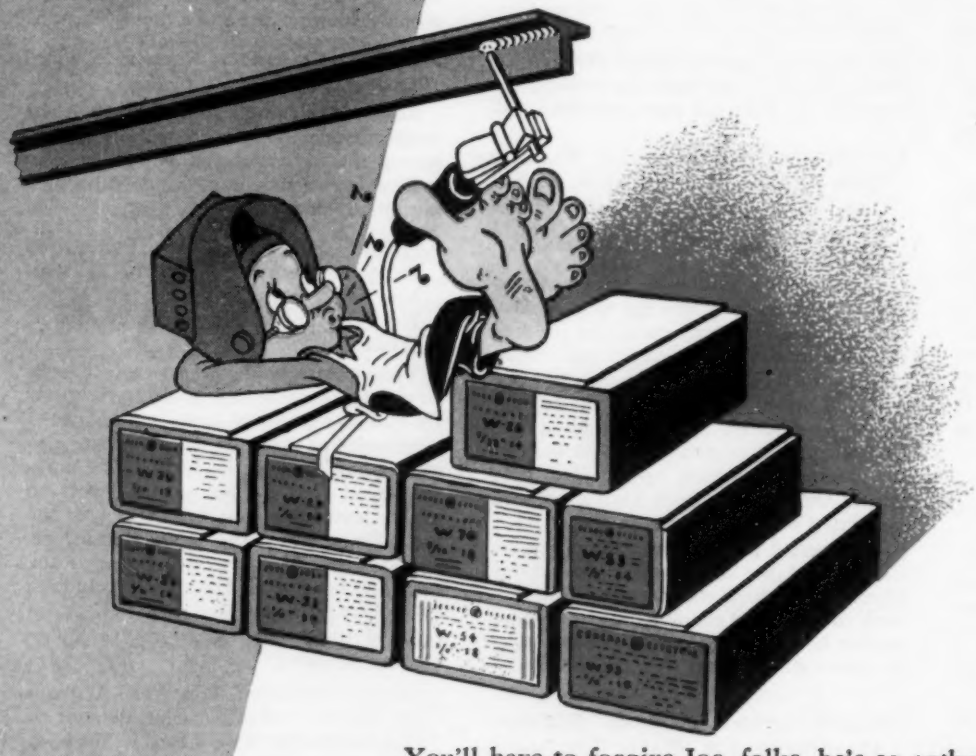
In this patent, a portable device for controlling relatively high electric currents is provided, and it includes a tubular handle having a guard collar thereon. A switch is mounted on one side of the guard collar and connected to terminals of conductors in the control circuit being regulated by the device.

2,443,592—Heavy-Duty Electrode Holder—Norman A. Birch, Mahwah, N. J.

Birch's heavy-duty holder includes a tubular handle having an insulating shield at one end thereof. A spring-positioned plunger for engaging with an electrode is controlled by a cam member carried by the handle.

2,443,671—Arc Welding System—Alfred B. White, Murrysville, Pa., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

it's So Easy when



Hey, Joe MaGee! We know it's easy to make good welds with G-E electrodes—but we don't quite recommend welding with your toes! At any rate, you'd better pull that headshield down before striking the arc.

You'll have to forgive Joe, folks, he's so enthusiastic about G-E electrodes, he's ready to go to 'most any lengths to demonstrate how easy they are to use—and get better welds in the bargain! Joe knows he can depend upon every one of the 63 types of G-E electrodes, because rigid usability tests assure maximum quality and quantity of deposit. To pass these tests, G-E electrodes must offer the best type of stable arc transfer, proper contour of deposit, ease of slag removal, low spatter loss, and excellent appearance of the finished weld.

HERE'S WHAT USERS FIND . . .

Joe MaGee is not alone in his enthusiasm for G-E rods. Here's just one example . . . the Peshastin Lumber and Box Co. of Peshastin, Washington, felt completely satisfied with the electrodes they were using and saw no reason for changing. However, after trying a sample of G-E W-25 electrode, they promptly placed an order for their production requirements, and have been a constant user of G-E electrodes ever since.

Yes, the proof of the electrode is in the welding. Your G-E Arc-welding Distributor will be glad to supply you with electrode samples—in fact, to service *all* of your arc-welding requirements. And in the meantime, why not clip and mail the coupon for a copy of our handy new, pocket-size electrode catalog and manual, GES-3571.

HAVE YOU SEEN "ARC WELDING AT WORK"? It's a brand new, 30-minute, sound motion picture in color—major component of General Electric's new *More Power to America* program on Electric Arc Welding. The film and accompanying literature point out clearly the design and production advantages inherent in the three major types of arc welding—metal-arc, Inert-Arc, and atomic-hydrogen. Your G-E Arc-welding Distributor will gladly arrange a showing for you.

Joe MaGee
Sect. C673-71
Apparatus Department
General Electric Company
Schenectady 5, N. Y.

☐ Send me one of your new electrode catalog-manuals (GES-3571), Joe—pocket-sized for handy reference.
☐ Yes, I'd like to see "Arc Welding at Work".

Name.....

Company.....

Address.....

City..... State.....

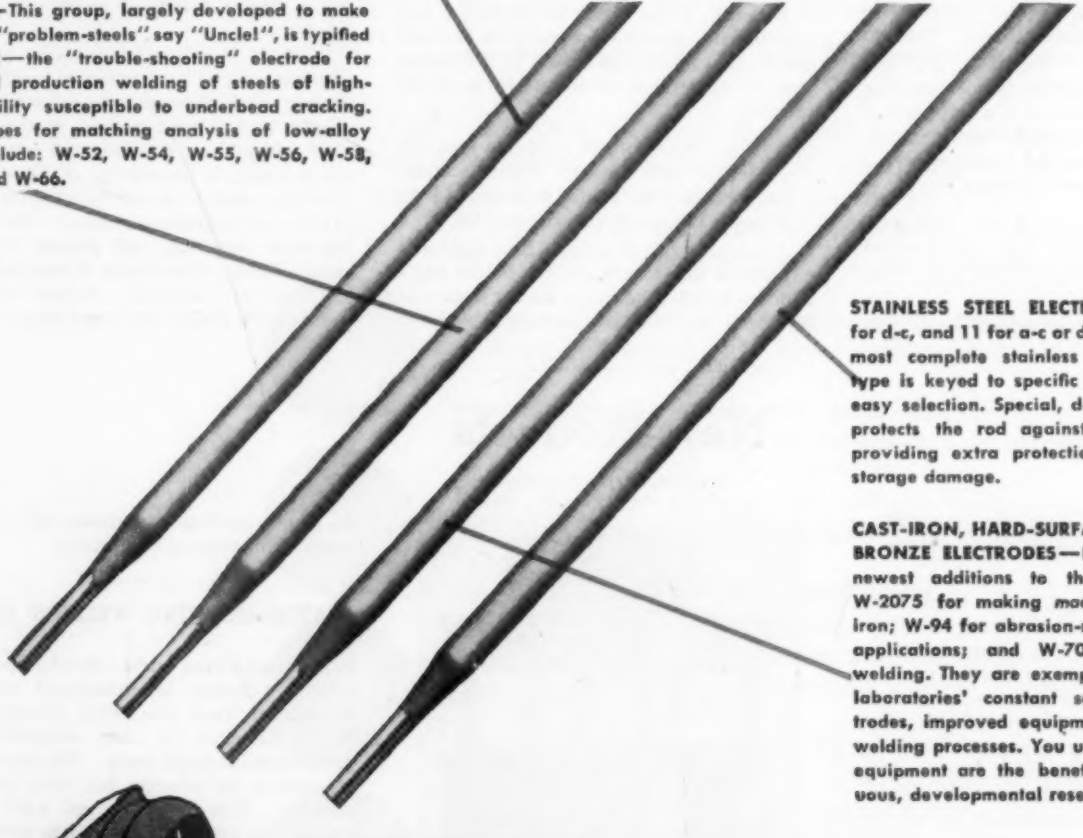
...you use...

ARC-WELDING ELECTRODES

The 63 varieties of G-E electrodes, each developed for a specific application or type of welding, may be classified into four major categories. Whether you're welding mild steel, stainless or other alloys . . . horizontal, vertical, or overhead . . . a-c or d-c . . . , you'll likely find a G-E electrode designed for the very job you're doing.

MILD-STEEL AND GENERAL-PURPOSE ELECTRODES—This group of 9 types is headed by W-28, a *new* general-purpose, all-position rod with an unusually stable arc that produces welds of superior appearance, at high speeds, with minimum convexity. Other electrodes in this group are available specifically for horizontal, vertical, or overhead welding, etc.

SPECIAL-PURPOSE AND LOW-HYDROGEN ELECTRODES—This group, largely developed to make so-called "problem-steels" say "Uncle!", is typified by W-32—the "trouble-shooting" electrode for successful production welding of steels of high-hardenability susceptible to underbead cracking. Other types for matching analysis of low-alloy steels include: W-52, W-54, W-55, W-56, W-58, W-59, and W-66.



STAINLESS STEEL ELECTRODES—27 types (16 for d-c, and 11 for a-c or d-c) make this one of the most complete stainless lines available. Each type is keyed to specific AISI code numbers for easy selection. Special, double-carton packaging protects the rod against moisture as well as providing extra protection against transit and storage damage.

CAST-IRON, HARD-SURFACING, & PHOSPHOR-BRONZE ELECTRODES—Herein are some of the newest additions to the G-E electrode line; W-2075 for making *machinable* welds on cast-iron; W-94 for abrasion-resistant, hard-surfacing applications; and W-70 for phosphor-bronze welding. They are exemplary of G.E.'s welding laboratories' constant search for better electrodes, improved equipment, and more efficient welding processes. You users of G-E arc-welding equipment are the beneficiaries of this continuous, developmental research program.

Copyright 1948, General Electric Co.

"A-C or D-C . . .
there's G-E Arc-welding Equipment for Every Application!"

ARC WELDERS • ELECTRODES • ACCESSORIES

GENERAL ELECTRIC

673-11

This welding system includes a source of direct current having output control means and a saturable reactor is provided in series connection with the welding circuit. Means are provided for varying the saturation point of the reactor, which means are operatively connected to the output control means of the energy source for variation in accordance with the output of the source.

2,443,710—Method of Flame-Cutting Metal Plates and Forming Shaped Edges Thereon—John H. Rountree, Plainfield, N. J., assignor to The Linde Air Products Co., a corporation of Ohio.

The cutting method patented includes the steps of moving oxygen cutting streams along adjacent parallel paths on the same surface of the plate to produce two nonintersecting kerfs through the plate and to provide a heated metal membrane between the two kerfs. Another oxygen cutting stream is moved concurrently with and behind the two cutting streams and angularly positioned so as to cut a kerf in the plate to form a second face thereon, and cut a kerf through the heated membrane, to prevent deflection of the last-mentioned cutting stream against the plate face formed by one of the first two cutting streams mentioned above.

2,443,771—Welding Machine—Edwin A. Mallett, Warren, Ohio, assignor to The Taylor-Winfield Corp., Warren, Ohio, a corporation of Ohio.

This patent relates to resistance welding apparatus and it includes a support, a track and a frame moving along the track. A wheel electrode on the frame effects a weld as the frame moves along a track.

2,443,776—Remote Control System Particularly for Arc Welding—Frank Rimmington, Potters Bar, England.

Rimmington's circuit relates to an electric resistance spot-welding apparatus wherein means are provided for moving the electrode to and from contact with the work. Control switches are provided for energizing a transformer in opposite directions in successive welding cycles. An additional means short circuits the primary winding of the transformer at the time of disengagement of the electrode from the work.

2,443,932—Welded Steel Articles and Method for Making Same—Edmund L. Rolff, Chicago, and Henry B. Wantland, Evanston, Ill., assignors to Carnegie-Illinois Steel Corp., a corporation of New Jersey.

This patent relates to the hardening and stress relieving of welded steel articles having a special composition. The method comprises maintaining the articles between 700 and 1000° F. for hardening same by a precipitation action after which the articles are stress relieved at a temperature between 1050 and 1200° F.

2,443,965—Control of Flash Butt Welders—Melvin M. Seeloff, Warren Ohio, assignor to The Taylor-Winfield Corp., Warren, Ohio, a corporation of Ohio.

This welding apparatus has a movable workholding platen, the position of which is controlled by a double acting cylinder. A movable jet-tube has its discharge end positioned opposite inlet ports for the cylinder whereby the movement of the platen may be controlled by the position of the jet-tube.

2,443,966—Welding Electrode Holder—Melvin M. Seeloff, Warren, Ohio, assignor to The Taylor-Winfield Corp., Warren, Ohio, a corporation of Ohio.

A special type of an electrode holder is covered in this patent and the holder has a tubular member having a socket device at its lower end for positioning a welding electrode tip. A tube is positioned in the member and is yieldably supported therein whereas a rod is also yieldably mounted in the tubular member above and spaced from the tube whereby a fluid-tight connection is provided between the upper end of the tube and the tubular member which has an inlet port formed therein adjacent the upper end of the tube.

Employment Service Bulletin

POSITIONS VACANT

V-224. Research Electrical Engineer. Interested in electronic research and development in Research Welding Department. Interested in Supersonics, electronic controls and design and testing of automatic welding equipment. Applicant must submit details of qualifications and experience.

V-225. Research Welding Metallurgist. Metallurgist with Welding background interested in welding research. Able to carry out research program. Knowledge of welding of dissimilar metals, brazing and knowledge of electrode manufacture very helpful. Applicant must submit details of qualifications and experience.

V-227. Metallurgist to assist in summarization and evaluation of welding research work through the preparation of digests and critical reviews of the literature. Should have a thorough metallurgical training, a knowledge of French and German, ability to write and some training in summarizing articles. Ability to separate essentials and present them in usable form. Knowledge of welding helpful, but not essential. Salary commensurate with ability and experience.

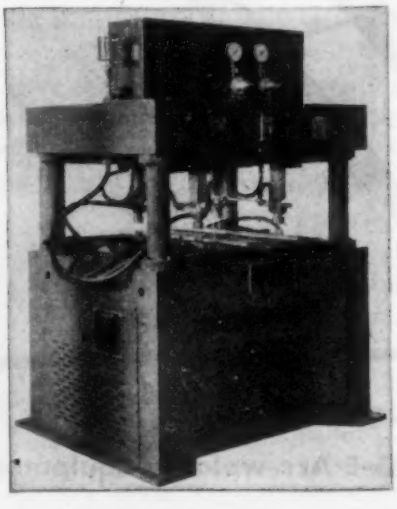
New Products

(*Continued from page 652*)

THE SCIAKY MG-4 MULTIPLE HEAD FOUR-POINT PROJECTION WELDER

A special multiple projection welder was recently designed for the Pressed Steel Car Co., Domestic Appliance Division. This machine, built by Sciaky Bros., Inc., replaced an operation formerly accomplished by a spot welder, and is responsible for two highly important advantages: (1) Production rate was increased from 80 to 360 units per hour and (2) the type of weld assured a perfect indentation-free surface on the exposed side of the panel.

This machine is rated 100 kva. at 50% duty cycle, and guaranteed to perform the welding of 4 clips simultaneously on 4 sizes of stove panels. The electrode cylinders are hydraulically operated and adjustable to the 4 sizes of stove panels. This machine is complete with all electronic controls integrally mounted. Considering loading, welding and unloading time, it is capable of producing, under good conditions, 400 units in one 50-min. hour.



Volume 2, No. 6, of *Resistance Welding at Work* describes completely the above machine's operation, together with various other spot-welding equipment.

SPATTER-RESISTING WELDERS' CLAMP

An important new development in welders' clamps is announced by The Cincinnati Tool Co., 4006 Montgomery Rd., Cincinnati 12, Ohio, manufacturers of mechanics' hand tools. The formation of spatter on clamps has long plagued welders. Now, a patented solid alloy screw that permanently resists spatter is provided on the new Hargrave No. 41 Light Service Welders' Clamps.

The manufacturer states that this anti-spatter screw will sharply reduce early replacements of clamps necessitated by spatter formation. In addition, the company states, a new forged steel, heat-treated frame is provided for this clamp to add to its durability and length of service. For complete information write for bulletin No. B60.

lots of Drive

That's why P&H "AP" electrodes produce sound welds *in all positions* — *faster and at lower cost*

"AP" is a 6010 electrode that does most anything you ask of it — on production, construction, or maintenance work. The secret of its success lies in the drive of its spray-type arc. This drive gives you plenty of penetration — the kind of penetration that lets you weld in all positions with good speed and good results.

In addition to easy manipulation and speed, here are a few additional features that save welding time and money:

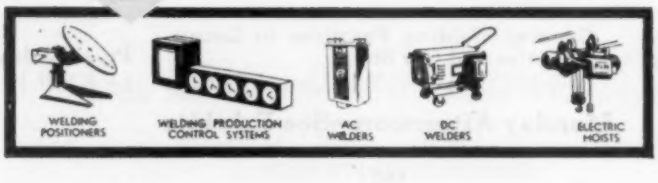
Good tensile strength and ductility — "AP" rods are especially suitable for work where tied-up stresses are involved.

Low spatter loss — The compounding of "AP's" special cellulose coating reduces spatter to a minimum.

Slag removal is quick and easy — "AP's" flat-shaped bead is covered with an unusually thin layer of slag that can be removed easily. This feature and the absence of spatter saves considerable cleaning time and assures better-looking jobs.

X-ray quality welds — Freedom from porosity is another important characteristic of "AP." That is why "AP" is the electrode to use when you desire a high-quality X-ray deposit.

Make a drive on your welding costs. Reduce them with P&H "AP" electrodes. Let your P&H representative or distributor show you why "AP" gets better results. Write us for literature.



P&H

Welding Electrodes
4551 West National Avenue
Milwaukee 14, Wisconsin

HARNISCHFEGER CORPORATION

TENTATIVE PROGRAM

AMERICAN WELDING SOCIETY TWENTY-NINTH ANNUAL MEETING WEEK OF OCTOBER 24, 1948

BELLEVUE-STRATFORD HOTEL, PHILADELPHIA, PA.

WELDING AND CUTTING EXHIBITS AND DEMONSTRATIONS

NATIONAL METAL EXPOSITION

COMMERCIAL MUSEUM AND CONVENTION HALLS

HOURS OF THE EXPOSITION

Monday, Tuesday and Wednesday—October 25 to 27
12 Noon to 10:30 P.M.

Thursday and Friday—October 28 and 29
10:00 A.M. to 6:00 P.M.

Admission by special invitation or by A.W.S. registration badge or membership card of any participating Technical Society.

TECHNICAL SESSIONS

All Technical Sessions will positively start on time.

No Stenotype Reporter—Members desiring to discuss papers are urgently requested to prepare discussion in writing in advance of the meeting and to send copies to Headquarters, as those preparing written discussion will be given preference at the session. Members and guests giving extemporaneous discussion at meeting should forward a written discussion as soon as possible after the meeting.

PRESIDENT'S RECEPTION
SUNDAY, OCTOBER 24th, 5 to 7 P.M.
Burgundy Room

MONDAY, OCTOBER 25th, Morning—9:30 A.M.
THREE SIMULTANEOUS SESSIONS

SHIP DESIGN
South Garden

Chairman—H. W. PIERCE, New York Shipbuilding Corp.

Co-Chairman—R. L. DEILY, Bethlehem Steel Co.

New Factors to Be Considered in the Design and Welding of Ships
by MILTON FORMAN, Battelle Memorial Institute

Riveted vs. Welded Structure
by E. M. MacCUTCHEON, David Taylor Model Basin, U. S. N.

Repair of Welded Ships
by L. E. BLEDSOE, Newport News Shipbuilding & Drydock Co.

RAILROAD
North Garden

Chairman—J. W. SHEFFER, American Car & Foundry Co.

Co-Chairman—A. J. RAYMO, The Baldwin Locomotive Works

Submerged-Arc Welding of Box and Hopper Cars
by E. A. WATSON, American Car & Foundry Co.

Welding the Modern Diesel Locomotive
by H. S. SWAN, American Locomotive Company

General Welding Practices in Locomotive and Car Shops
by J. MICHNE, New York Central System

STORAGE TANKS, PRESSURE VESSELS & PIPING
Rose Garden

Chairman—A. C. WEIGEL, Combustion Engineering Co.

Co-Chairman—E. B. STOLLE, Midwest Piping & Supply Co.

Field Erected Storage Tanks of Aluminum
by FRED L. PLUMMER, Hammond Iron Works

Sampling of Welds by Trepanning and Allied Methods
by R. B. LINCOLN, Pittsburgh Testing Laboratory

Pipe Welding
by JOHN H. ZINK, Heat & Power Corp.

Monday Afternoon—See Exhibits

Monday Afternoon, 4:30 to 6:00 P.M.

EDUCATIONAL LECTURE SERIES
Convention Hall

Chairman—DR. G. E. DOAN, Lehigh University

The Metallurgy of Arc Welds in Steel
by DR. R. D. STOUT, Lehigh University

Monday Evening—8:00 P.M.
Rose Garden

Chairman—H. O. HILL, President, American Welding Society

Co-Chairman—E. V. DAVID, Chairman, Convention Committee

AWARDS OF PRIZES AND MEDALS

ADAMS LECTURE

The Metallurgy of Covered Electrode Weld Metal
by G. E. CLAUSSEN, Reid-Avery Co.

TUESDAY, OCTOBER 26th, Morning 9:30 A.M.
THREE SIMULTANEOUS SESSIONS

SYMPOSIUM ON SHIP STRUCTURE RESEARCH
South Garden

Chairman—CAPTAIN L. V. HONSINGER, U.S.N.
Chairman, Ship Structures Committee

Co-Chairman—J. LYELL WILSON, American Bureau of Shipping

Explosion Tests
by G. S. MIKHALAPOV, Air Reduction Sales Co.

A Detailed Study of Welded Joints by Means of the Static Notch Bar Eccentric Tensile Test
by GEORGE SACHS, L. J. EBERT and A. W. DANA, Case Institute of Technology

Fracture Characteristics of Ship Plate in Certain Small Scale Tests
by E. P. KLIER, F. C. WAGNER and M. GENSAMER, The Pennsylvania State College

Axial Tension Impact Tests of Structural Steel
by W. H. BRUCKNER and N. M. NEWMARK, University of Illinois

RAILROAD
North Garden

Chairman—A. G. OEHLER, Railway Mechanical Engineer

Co-Chairman—L. E. GRANT, Chicago, Milwaukee, St. Paul & Pacific R.R. Co.

Diesel Locomotive Welding
by R. L. REX, Air Reduction Sales Co.

Submerged Melt and Inert Gas Shielded Electric Welding Applied to Railroad Cars
by C. R. STRUTZ, The Oxweld Railroad Service Co.

Welding Practice in Welding AISI Specification 430 (18% Chrome Steel) in Locomotive Fire Box Applications
by HOWARD L. MILLER, Republic Steel Corp.

Railroad Car Welding
by A. M. UNGER, Pullman Standard Car Mfg. Co.

HIGH ALLOYS-NON FERROUS
Rose Garden

Chairman—O. B. J. FRASER, The International Nickel Co.

Co-Chairman—R. H. ABORN, United States Steel Corp.

The Effect of Weld Metal Composition on the Strength and Ductility of 18% Cr-35% Ni Welds
by DAVID ROZET, HALLOCK C. CAMPBELL and R. DAVID THOMAS, JR., Arcos Corp.

Use of Alloy and Welding in High Temperature Service in Oil and Gas Processing
by M. E. HOLMBERG, Phillips Petroleum Company

Stress Corrosion in Naval Brass
by BELA RONAY, U. S. Navy Engrg. Experiment Station

Effect of Residual Compression on the Fatigue of Notched Aluminum Alloys
by D. ROSENTHAL, G. SINES, and G. ZIZICAS, University of California

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Tuesday Afternoon, 2:00 P.M.

THREE SIMULTANEOUS SESSIONS

SYMPOSIUM ON SHIP STRUCTURE RESEARCH
South Garden

Chairman—COMMANDER R. D. SCHMIDTMAN, U. S. Coast Guard

Co-Chairman—FINN JONASSEN, National Research Council

The Development of Weldable High Strength Steels
by C. E. SIMS, Battelle Memorial Institute

The Testing of Highly Restrained Welded Structural Joints Made from High Strength Steel
by A. BOODBERG and EARL R. PARKER University of California

The Evaluation of Notch Sensitivity Characteristics of Steel by the Tear Test Method and Its Application to Quality Control of Ship Plate
by NOAH A. KAHN and EMIL A. IMBEMBO, New York Navy Yard

BRAZING AND METALLIZING
North Garden

Chairman—J. R. WIRT, Delco-Remy Division, GMC

Co-Chairman—G. W. OXLEY, Standard Oil Development Co.

Low Temperature Silver Alloy Brazing Copper Beryllium Alloys
by A. M. SETAPEN and W. D. WARREN, Handy & Harman

Metallizing as a Production Process
by KNOWLES B. SMITH, Dix Engineering Co.

CUTTING
Rose Garden

Chairman—H. B. SEYDEL, Air Reduction Sales Co.

Co-Chairman—E. R. McCLUNG, Lukenweld, Inc.

Powder Cutting and Scarfing in the Steel Industry
by FRANK A. SNYDER, Carnegie-Illinois Steel Corp.

A Method of Controlling Cutting Tip Clearance
by R. B. STEELE and H. G. HUGHEY, Air Reduction Sales Co.

The Stability of Oxyacetylene Flames
by L. D. CONTA, Air Reduction Sales Co.

OPEN MEETING RAILROAD COMMITTEE—2:00 P.M.
Burgundy Room

Tuesday Afternoon, 4:30 to 6:00 P.M.

EDUCATIONAL LECTURE SERIES
Convention Hall

Chairman—DR. W. F. HESS,
Rensselaer Polytechnic Institute

The Metallurgy of Arc Welds in Steel
by DR. R. D. STOUT, Lehigh University

Tuesday Evening—Free—See Exhibits

WEDNESDAY, OCTOBER 27th, Morning—9:30 A.M.
THREE SIMULTANEOUS SESSIONS

WELDABILITY
Rose Garden

Chairman—CLARENCE E. JACKSON,
Union Carbide and Carbon Research Labs., Inc.

Co-Chairman—R. E. SOMERS,
Bethlehem Steel Co.

Strain Aging in Welding Low Carbon Structural Steel
by W. H. BRUCKNER and W. E. ELLIS, University of Illinois

An Evaluation of the Influence of Chemical Composition of the Base Metal Upon the Performance of Metal-Arc Welded Joints
by J. HEUSCHKEL, Westinghouse Electric Corp., Research Labs., Welding Section

Notch Toughness of a Variety of Welded Low Carbon Steels
by DR. E. F. NIPPES, JR., and WARREN F. SAVAGE, Rensselaer Polytechnic Institute

Weldability of Cast Carbon and Alloy Steels
by SIDNEY LOW and V. T. MALCOLM, The Chapman Valve Mfg. Co.

ARCS AND ELECTRODES
North Garden

Chairman—J. H. DEPPELER,
Metal & Thermit Corp.

Co-Chairman—J. H. HUMBERSTONE,
Arcrods Corp.

Arc Phenomena with Electrodes Moving at High Speeds
by W. B. KOUWENHOVEN, Dean of School of Engineering, and T. B. JONES, Asst. Prof. E. E., Johns Hopkins University

An Investigation of Methods for Evaluating Welding Arc Stability and Their Application
by PROF. R. A. WYANT, DR. LAURISTON P. WINSOR, and L. M. SCHETKY, Rensselaer Polytechnic Institute

A Comparison of the Mechanical Properties of Arc Welds Made with Lime Coated and Cellulose Coated Electrodes
by F. W. DANIELS, F. S. GARDNER, and R. M. ROOD, General Electric Co.

RESISTANCE WELDING
South Garden

Chairman—G. N. SIEGER,
S. M. S. Corp.

Co-Chairman—K. W. OSTROM,
K. Wm. Ostrom & Co.

The Resistance Welding Characteristics of the Dry Disc Rectifier Welder
by R. H. BLAIR and C. E. SMITH, The Taylor-Winfield Corp.

The Importance of Temperature Measurements in the Establishment of Optimum Flash Welding Conditions
by R. M. CURRAN, P. PATRIARCA and W. F. HESS, Rensselaer Polytechnic Institute

Resistance Welding Cross Wires
by R. C. JONES, The Taylor-Winfield Corp.

Preliminary Test of Spot Weld Shunting in 24 ST Alclad
by A. R. HARD, State College of Washington

Wednesday Afternoon, 2:00 P.M.

THREE SIMULTANEOUS SESSIONS

CUTTING
North Garden

Chairman—A. B. GORDON,
The Linde Air Products Co.

Co-Chairman—R. D. THOMAS,
Arcos Corp.

Specialized Steel Mill Cutting Machines and Controls
by R. F. HELMKAMP and A. H. YOCH, Air Reduction Sales Co.

Corrosion Resistance of Powder-Cut Stainless Steels
by L. E. STARK and C. R. BISHOP, Union Carbide and Carbon Res. Labs., Inc.

Structural I-Beam Cut-Off Machine
by G. J. STRATE, Air Reduction Sales Co.

INERT-GAS-SHIELDED ARC WELDING
Rose Garden

Chairman—H. E. ROCKEFELLER,
The Linde Air Products Co.

Co-Chairman—WALTER MEHL,
Heintz Manufacturing Co.

The Effect of DC Component in AC Inert-Gas Arc Welding of Aluminum
by G. J. GIBSON and G. R. ROTHSCHILD, Air Reduction Sales Co.

Design Features of Inert-Gas-Shielded Arc Welding and Control Equipment
by N. E. ANDERSON, Air Reduction Sales Co.

The Effect of Wave Shape in Inert-Arc Welding Circuits
by R. W. TUTHILL, General Electric Co.

RESISTANCE WELDING
South Garden

Chairman—O. C. FREDERICK,
General Electric Co.

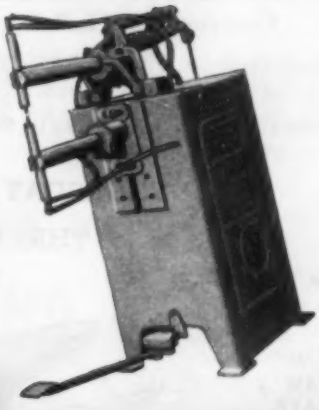
Co-Chairman—B. L. WISE,
National Electric Welding Machine Co.

Thermal Resistance of Metal Contacts
by W. B. KOUWENHOVEN, Dean of School of Engineering, and J. H. POTTER, Asst. Prof. M. E., The Johns Hopkins University

Projection Welding
by WENDELL F. HESS, Rensselaer Polytechnic Institute

Spotwelding Schedules for Nickel and Nickel Alloys
by F. G. HARKINS, Solar Aircraft Company

Here's the Economical Way to Modernize Your Small Spot Welders



Single enclosed unit includes timer and contactor— eliminates human element and assures UNIFORM weld quality

Class 8992 Type BBG-1 Controllers (illustrated above) are ideal for small foot-operated or motor-operated welders. A complete line of combination controllers for air-operated machines is also available.

Write **Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin, for Bulletin 8992.**

• Unit cost and spoilage go down—production goes up, where welding power is controlled automatically. It's a simple matter to modernize old machines with this single device which does the whole job automatically—does it quicker, better, and at low installation cost.

Check your welding equipment with the manufacturer or his representative. You may find that a small investment will bring a substantial improvement in both quality and output.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D CANADA, LTD., TORONTO, ONTARIO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Wednesday Afternoon, 4:30 to 6:00 P.M.

EDUCATIONAL LECTURE SERIES
Convention Hall

Chairman—DR. FINN JONASSEN, National Research Council

The Metallurgy of Arc Welds in Steel
by R. D. STOUT, Lehigh University

Wednesday Evening—8:00 P.M.

SECTION OFFICERS CONFERENCE
Clover Room

UNIVERSITY CONFERENCE
Green Room

THURSDAY, OCTOBER 28th, Morning—9:30 A.M.

THREE SIMULTANEOUS SESSIONS

STRUCTURAL
Rose Garden

Chairman—W. E. HENDRICKS, Belmont Iron Works

Co-Chairman—VAN RENSSELAER P. SAXE, Consulting Engineer

Welded Bridges
by LaMOTTE GROVER, Air Reduction Sales Co.

Fabrication of Structural Steel Sections by Submerged Melt Welding
by J. W. TIPPETT, The Linde Air Products Co.

Flexible Beam and Girder Connections in a Large Welded Structure
by HARRY GREAVES, The Atlantic Refining Co.

The Plastic Strength of Steel Beams
by W. H. LUXION, L. S. BEEDLE, C. H. YANG, and B. G. JOHNSTON, Fritz Engineering Laboratory, Lehigh University

INERT-GAS-SHIELDED ARC WELDING
North Garden

Chairman—R. F. WYER, General Electric Co.

Co-Chairman—G. O. HOGLUND, Aluminum Company of America

Practical Aspects of the Inert Gas Shielded Arc Welding Process
by A. N. KUGLER and H. A. HUFF, Jr., Air Reduction Sales Co.

Welding Pure Copper for Pressure Vessels to ASME U69 and Case 934 with Heliarc Process
by JOHN W. MORTIMER, Whitlock Mfg. Co.

Production Heliwelding Stainless Steel
by NEWTON A. BLICKMAN, S. Blickman, Inc.

Inert-Gas-Shielded Spot Welding
by FRANK J. PILIA, The Linde Air Products Co.

MAINTENANCE
South Garden

Chairman—GEORGE NIGH, Tide Water Associated Oil Co.

Co-Chairman—H. R. MORRISON, The Linde Air Products Co.

Diversified Welding in Chemical Plant Maintenance
by ELVIN M. RATCLIFF, Ethyl Corp.

Welding in Steel Mill Maintenance
by L. P. ELLY, Bethlehem Steel Co.

What a Maintenance Department Can Do with Welding and Cutting
by JAMISON MOORE, Union Bag & Paper Co.

Thursday Afternoon—Free—Visit Exhibits

Thursday Evening

ANNUAL DINNER
Rose Garden

FRIDAY, OCTOBER 29th, Morning—9:30 A.M.

THREE SIMULTANEOUS SESSIONS

AUTOMATIC WELDING
South Garden

Chairman—T. M. JACKSON, Sun Shipbuilding & Dry Dock Co.

Co-Chairman—GEORGE JOHNSON, The Lincoln Electric Co.

Automatic Submerged-Arc Welding of One-Inch Alloy Steel Plates
by HOWARD L. MILLER, Republic Steel Corp.

Production Tooling for Automatic Welding
by CECIL C. PECK, Cecil C. Peck Co.

MISCELLANEOUS
Rose Garden

Chairman—GEO. TREFTS, Farrar & Trefts Inc.

Co-Chairman—A. A. HOLZBAUR, Sun Shipbuilding & Dry Dock Co.

Ceramic and Composite Back-Ups for Grooved Weld Joints
by CHESTER R. AUSTIN and P. J. RIEPPEL Battelle Memorial Institute

All Welded Fabrication of Shipping Containers by Resistance and Fusion Methods
by G. J. GREEN and D. H. MARLIN, Dravo Corp.

The Future Welded Design of Farm Equipment
by ERNEST J. KOOP, Ernest J. Koop Welding and Blacksmith Shop

Evaluation of Effects of Residual Stresses
by T. W. GREENE, The Linde Air Products Co.

HARD FACING AND FLAME HARDENING
North Garden

Chairman—C. H. JENNINGS, Westinghouse Electric Corp.

Co-Chairman—R. A. GUENZEL, Southern Oxygen Co.

The Economies of Hard Facing
by J. J. BARRY, and ALBERT MULLER, Air Reduction Sales Co.

Hard Facing and Surfacing with the Inert-Gas-Shielded Arc Welding Process
by K. H. KOOPMAN, The Linde Air Products Co.

Flame Hardening Methods and Techniques
by J. R. BURG, The Baldwin Locomotive Works

YOU SAVE IN 3 WAYS

WHEN YOU JOIN STEEL TUBE WITH

REVERE No. 456 LOW FUMING BRONZE WELDING ROD

You make important savings at every step of the way when you join steel tube frames for bicycles, furniture, etc., with Revere No. 456 Low Fuming Bronze Welding Rod. Here's how:

1. **FASTER ASSEMBLY**—You spend less time assembling the parts to be joined, because the high strength of Revere No. 456 permits wide assembly tolerances and still provides strong, neatly-finished joints with well-formed fillets.

2. **LESS "CLEAN-UP"**—"Clean-up" costs are materially reduced, because Revere No. 456 is low fuming and thus enables you to get more accurate placement of the weld metal.

3. **REJECTIONS ELIMINATED**—Inspection rejections and failures in the field due to breakage of joints are practically eliminated.

In addition to these three direct cost-saving advantages, Revere No. 456 enables you to work in comfort with no excessive fumes, and it produces joints that are stronger than the steel tube. Try Revere No. 456 and see for yourself how you can cut costs, save time and get better results with this "flame tested" rod in the striking red, white and blue package.

Other Revere Welding Rods are: Revere Bronze 380, Manganese Bronze, Herculoy, Phosphor Bronzes, Brass (Brazing Rod), Silicon Deoxidized Copper and Electrolytic Copper. All come in 100-pound cases or in 25-pound cartons, net weight, and are stocked by Revere Welding Rod Distributors in all parts of the country. Write for folder giving technical data and net prices.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities. Distributors Everywhere.

Friday Afternoon
2:00 P.M.

BUSINESS SESSION
Clover Room

3:00 P.M.

BOARD OF DIRECTORS MEETING
Green Room

Registration—Blue Room

LADIES' ENTERTAINMENT
(To Be Announced Later)

Charges for Technical Session papers are:
September Journal, October Journal and "Preprint" each 50¢ per copy to members; $1.00 to nonmembers.

List of New Members

June 1 to June 30, 1948

BRIDGEPORT
Lee, James P. (C)
Sapega, August E. (C)

CHATTANOOGA
Edwards, Robert C. (C)

CHICAGO
Chocole, Joseph F. (B)
Hess, Edwin A. (B)
Perkins, Roy B. Jr. (C)
Straz, Victor A. (C)
Thomas, W. E. (B)

CINCINNATI
Garfinkel, Stanley (D)

CLEVELAND
Adams, Harold E. (B)
Boom, W. B. (B)
Boose, George C. (C)
Brill, W. E. (B)
Dyble, Edward (B)
Glasenapp, Allen H. (B)
Hill, Elmer (C)
Hoehn, Frank E. (B)
Louzecky, Paul (B)
Morgan, Chas. (B)
Novak, Edward D. (B)
Smith, Belmont D. (B)
Scheiman, James (D)

COLUMBUS
Wallace, Walton E. (B)

DAYTON
Tilley, John G. (C)

DETROIT
Hazen, Archie Weldon, Jr. (C)

INDIANA
Kittle, James C. (C)
Weathers, Don (C)

LEHIGH VALLEY
Edwardes, Vance P. (C)

LOS ANGELES
Laws, Charles M. (C)
Lester, Robert Wayland (C)
Pitney, H. M. (C)
Smallen, Harold (C)
Wiebe, A. H. (B)

NEW ORLEANS
Trippe, John W. (C)

NEW YORK
Cianflone, John (B)
Corkindale, Douglas M. (C)
Farrell, Edward James (B)
Geneau, Alberto J. (B)
Harris, George C. (C)
Lane, Robbins E (C)
Linsley, H. E. (C)
Martello, William Andrew (B)
Ruten, William H. (B)
Simon, Sigmund (B)
Stallings, Robert (C)

NORTHWEST
Jennings, Richard L. (C)
Lynum, Lloyd A. (C)
Plough, George (C)

NORTHWESTERN PA.
Fino, Alexander F. (B)
Prenatt, James P. (C)

OKLAHOMA CITY
Blasingame, Max (C)
Burnsides, Harold (C)
Childs, Fred W. (C)
Crawford, H. C. (C)
Davidson, Willliam R. (C)
Helms, Clyde Herbert (C)
Manning, H. G. (C)
Mayfield, Lee, Jr. (C)
Pooler, Irl A. (C)
Pooler, Jake H. (C)
Reynolds, W. H. (C)
Sanders, J. J. (C)
Story, Bill (C)
Verner, Frank (C)
Wedel, Paul Milton (C)
White, Homer X. (C)
Willard, Jim (C)

PASCAGOULA
Hammett, E. R. (C)
Von Feilitzen, Gunnar (C)

PEORIA
Baugh, Lester L. (C)
Brown, James D. (C)
Overbeck, Carl M. (C)

PHILADELPHIA
Adams, John H., Jr. (B)
O'Byrne, John P. (B)
Pompa, Leonard (C)

PITTSBURGH
Fulton, James A. (C)
Jenkins, Morton M. (C)

PUGET SOUND
Van Cleave, Bernard P. (C)
Whitman, Harold W. (C)

ST. LOUIS
Lischer, Melville W. (B)

SOUTH TEXAS
Ferguson, J. E. (B)
Head, W. D. (C)
May, S. T. (C)

TRI-STATE
Finnegan, V. E. (C)
Graves, Roy M. (B)
Hopkins, Guy C. (C)
Lang, H. A. (C)

WESTERN MICHIGAN
Hoffmyer, H. D. (C)
Wilson, D. C. (C)

WICHITA
Riley, Harry M. (D)

NOT IN SECTIONS
Anderson, J. Holmes (B)
Andrews, L. H. (C)
Belle, C. W., Jr. (C)
Brizendine, James C. (B)
Daniels, Gordon E. (C)
Fitzgerald, James E., Jr. (C)
McCan, Jno. H. (B)
McNeil, Douglas (C)
Miller, Dan C. (B)
Miller, M. M. (C)
Moss, James R. (B)
Oliphant, W. H. (B)
Pruett, Howard A. (C)
Riess, Rudolf (B)
Riggins, D. K. (C)
Williams, Furman F. (C)
Wilson, Fred T., Jr. (B)

Members Reclassified

During Month of June

CHICAGO
Roscoe, J. S. (C to B)

CLEVELAND
Scheffler, C. A. (C to B)

New Literature

(*Continued from page 646*)

ROCKER ARM WELDERS

A four-page technical bulletin (Bul No. 702), describing the new improved of air-operated standard 30- and 50- rocker arm welders for high produc spot welding of a wide range of light medium-duty applications, is now av able from Progressive Welder Co., 305 Outer Dr., Detroit 12.

The bulletin includes a complete t of performance data and specifications each of the 8 models under different c ditions of operation; diagrams show location and operation of various u and numerous line drawings illustra the manner in which the welders can used to weld different types of jobs.

WELDING OF HARD-TO-REPLACE PA

An impressive four-page bulletin stu ing low heat welding repairs of automo Equipment has been issued by Eute Welding Alloys Corp., New York. T publication is the first of a series of circulars entitled "Jim's Eutectips."

It is planned to issue this helpful bull bimonthly and assist welders in var phases of industrial welding repa Subsequent issues will cover the ma repairs on the Farm, in the Sheet Me Shop, in Plumbing, Shipbuilding, R roads, Foundries, Machine Building, craft, Textiles, etc. Those interes may be placed on the mailing list "Jim's Eutectips" by writing to Eute Welding Alloys Corp., 40 Worth New York 13, N. Y.

STANDARDIZED INTERCHANGEABL COMPONENTS WELDING GUNS

A 12-page technical bulletin (No. 40 showing in text and illustrations how new standardized welding guns are b up by combining standardized and in changeable components has been issued Progressive Welder Co., 3050 E. Ou Dr., Detroit, Mich. Eliminating spe gun-designing time and cost for most p welding operations, the standardi parts—including jaw extensions, electr holders, air or hydraulic operating cyl ders, switches, etc.—may be assembled five basic types of gun chassis (in li duty and heavy duty models) to produ almost any gun shape desired. By mer varying standardized jaw extensions a electrodes on one gun chassis, for instan as many as 57,600 gun shapes can be p duced.